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INTRA-EMPIRE TRADE

The Opportunity For Agriculture

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Part I.

Possibility

The export of farm products is becoming more difficult from year to year. Many countries are limiting importations of certain foodstuffs. This has necessitated a revival of interest in the British market. The trend of trade during recent months has been toward increased exports to Britain as other outlets have become restricted. A re-examination of the scope of this market and of the opportunity for expansion of exports of farm products in that direction is the subject of this discussion.

The dependence of Britain on imported foodstuffs is generally known. The extent of this dependence on foreign countries, the proportion of the food bill spent on various products, and the change in this respect in recent years are by no means so thoroughly realized. During the past decade the trend of Canadian trade has been toward European and other markets, more particularly in the case of grain. Recently trade restrictions in Europe have increased domestic production, and today Canadian farmers find themselves more keenly interested in the British market than they have been since pre-war days when that market was much more important relatively than it has been during the post-war years.

The significant development with which Canada is concerned in international trade in farm products during the past two decades is that while expansion in exports from this country has been almost entirely confined to grain, the expansion of imports by Britain has been practically entirely confined to other things, a major portion of which was contributed by foreign countries. These foreign countries have, one after another, shut out goods from Canada as well as from other parts of the Empire. The possible and necessary alternative is to re-examine British imports with a view to increasing, and in some cases re-establishing, export trade within the Empire.

The possibility of this alternative is revealed when it is stated in general terms that Great Britain imports about four-fifths of the breadstuffs and fruit she consumes, one-half the meat, eggs and dairy products, and one-third the fish and vegetables. The import food bill, which reached a million and a quarter pounds sterling per day in 1929, still represented one million per day in 1931 when prices were much lower. That this reduction was in value rather than in quantity may be noted as we proceed.

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This food market has been found tempting to most of the exporting food countries of the world. Britain annually absorbs around 20% of the world export of barley, 21% of that of sugar, 28% of the oats exported, 32% of the wheat, 40% of the eggs, 49% of the cheese, 64% of the condensed and evaporated milk, 66% of the beef and veal, 67% of the butter, 67% of the bacon, ham and pork, and 93% of the world export of mutton and lamb. These figures must vary from year to year, particularly in some lines such as wheat. But so far this is not due as much to the instability of the demand in Britain as to the somewhat erratic demand of other places. It is probable that, on account of the good crops and increased acreages in Germany, France and Italy, Britain will absorb nearer 40% than 30% of the total wheat entering international trade during the current crop year.

It is apparent that Britain is not only the most important but also the most steady market for surplus food products. Some other countries import farm products when local scarcity exists and the purchasing power is available. British demand has, so far, been more reliable for these goods, and in some lines the expansion has been enormous.

Expansion in trade within the Empire is not only a possible, but also apparently the necessary, alternative to the foreign market. During the prosperous post-war decade just passed, it has not been difficult for many food exporting countries to get rid of their surplus in several directions. Australia has been able to dispose of wheat to the Orient; Canada has sent wheat and flour all over the world, and its surplus of meat and milk to the United States. Recently, however, a change has taken place in the international trade. Many countries have imposed embargoes, tariffs or quotas against the food products of other countries. These restrictions to international trade have stimulated home production and lessened the dependence on imports. In the meantime, Britain increases importations. How this works out is revealed in a recent report of a week's chartering of grain boats from Montreal. Eleven boats were included. One went to the continent, six to the continent with United Kingdom options, and four straight to the United Kingdom. Such conditions reveal the necessity for increased trade within the Empire. It is necessary for countries with a surplus of farm products to cater to this great market if they wish to get rid of their stuff, because other markets, for the present at least, have failed them.

Necessity

Though countries outside the Empire have recently displayed a tendency to restrict purchases of food products, apparently it has by no means lessened their ambition to provide Britain with as large a quantity as possible of their surpluses. During 1931 Britain imported over eight million hundredweights of butter, slightly over half of it from foreign countries. During the same year imports of bacon exceeded eleven million hundredweights, 96% from foreign countries. Imports of eggs amounted to twenty-six million great hundreds, 76% from foreign countries.

Obviously, if the countries providing Britain with this food had taken in exchange some other products, they might have continued the movement. This, however, they failed to do, according to the records of 1930 which are given in Table 1.

TABLE 1.—*British trade*, 1930 (*1*)

	Imports from	Exports to
U. S. A.	£153,496,858	£39,933,615
Argentina	56,665,769	25,676,179
Denmark	54,117,596	10,990,190
Holland	39,523,812	23,009,498
Belgium	38,015,736	21,578,948
Soviet Union	34,235,002	9,291,307
Sweden	22,580,948	10,935,670
Total	398,635,721	141,415,407

These seven countries which have sent considerable quantities of food to Britain supplied that country with goods to the value of £257,220,314 more than that of the goods they purchased in exchange. If and when other countries absorbed the balance, such a condition created no great difficulty. Recently the tendency has been to deal with those that deal with you. One way traffic in international trade becomes particularly unpopular when business is as difficult to carry on as it has been during the past few years.

Increased trade within the Empire is taking place already, hence the idea has the advantage of working with the trend of the times rather than against it. During the first six months of 1932 imports of Britain from the United States decreased from 227 to 148 million dollars, while the exports declined from 70 to 41. This leaves an adverse balance of 107 million in the first half of 1932 as compared with 157 million in the same period of 1931, a reduction in the adverse balance of 50 million.

Canada purchased 133 million dollars worth from the United States in the first half of 1932 as compared with 232 million in the same period of 1931, while exports declined from 140 to 100 million. This reduces the adverse balance in the first half of 1932 by 59 million dollars, as compared with the previous year. These figures are only an example of how these adverse trade balances are corrected after a time, particularly when countries get tired of their position and perhaps too hard pressed to carry on one way traffic.

Trade restrictions have slowed down international trade considerably during the past two years. There are some lines of trade which have not suffered in quantity handled. The outstanding example of a trade which has expanded in quantity during the past two years is the food imports of Britain. That country is going to purchase food of certain definite lines, and from whom? From the British Commonwealth of Nations preferably if it will supply them.

The development of intra-imperial trade has been to a certain degree forced upon the British Commonwealth of Nations by the fiscal policies of other nations. It is at the moment the line of least resistance for the exporters of farm products within that commonwealth of nations.

POTENTIALITY

Realization of the possibilities of increased exports of food stuffs within the Empire may be more clear when consideration is given to the change in fiscal legislation in Britain within the past year. In the first place, the corn laws have been re-established with a guaranteed price for home grown wheat. Duties have been imposed against foreign fruit, vegetables and meats, and it is proposed to extend definite assistance to the pig raiser and the dairy farmer of the British Isles.

Britain plans on growing more of its fruit, vegetables and grain than formerly. Also expansion in production of poultry products, pork and dairy products is planned. It is claimed that expansion in arable farming may be considerable without sacrificing one head of meat animals. Mechanized farming, of which more is heard in Britain than in Canada at the moment, will require fewer horses. By more careful cultivation of their own back yard, as some have termed it, expectations are that dependence will be lessened on food importations from any source.

With this trend in mind, it may not be quite safe to calculate on the steadily expanding market in all lines of food products which has characterized the past two decades. Yet this expansion is the crux of the situation in considering the potentialities of increased intra-empire trade.

TABLE 2.—*Expansion of British food imports*

	1909-14 av.		1924-29 av.
Wheat (*2*)	217,700,000 bu.		225,300,000 bu.
Flour (*2*)	5,193,000 bbls.		4,473,000 bbls.
	1911-13 av.	1924-26 av.	1931
	000 cwt.	000 cwt.	000 cwt.
Butter (*3*)	4,149	5,653	8,071
Cheese (*3*)	2,318	3,000	2,885
Condensed milk	1,210	2,283	2,801
Milk powder	46	152	366
Cream	9	80	179
	gt. hds.	gt. hds.	gt. hds.
Eggs	19,906	21,423	25,920
	cwt.	cwt.	cwt.
Egg products	(not available)	621	802
Poultry	262	360	667
Bacon	4,787	7,610	11,138
Hams	903	1,449	831
Pork, frozen and salted	259	268	432
Lard	1,627	831	2,549

With the decline of trade generally lamented, it is interesting to find any line which records such substantial expansion. Apparently, supplying the demand in Britain for imported food is, up to the present, an industry offering fairly regular employment.

Considerable difference in the rate of increase in imports of different products is recorded. Imports of wheat and flour show only slight expansion since 1913. Importations of butter show a substantial increase in 1924-26 over the pre-war years while the quantity imported in 1931 was almost double that of any year before the war. The 1931 increase has been attributed to the low price of butter in that year enabling its substitution for oleomargarine. The same reason has been given for increases in butter imports in Belgium, France, Italy and Switzerland in that year. Germany decreased imports in 1931 partly on account of public regulations. The expansion of British imports in 1931 should not be looked upon as a normal expansion and may not be repeated, yet it is recorded that for the first eight months of 1932 imports of butter were 20,464,000 lbs. greater than during the similar period of the previous year, while the imports of Germany declined by 35,107,000 lbs. during the same time (*4*).

Bacon importations reveal a more important increase than butter between the pre-war years and 1924-27. In 1931 the quantity of bacon imported was almost two and one-third times that of 1911-13. This was no doubt partly due to the declining price during 1931, and the lower price of 1932 may account for the increased importations in 1932 over 1931 as recorded so far. Therefore to be safe it would be unwise to consider the expansion in these lines as likely to continue at the present rate. When, however, per capita consumption is considered, it may be noted that a considerable increase has been gradually developing, the consumption per capita of butter having risen from 15.6 pounds in the years 1924-26 to 20.6 pounds in 1931.

The value of imports is a point not to be overlooked. During 1930 and 1931 butter imports were greater in value than any other food commodity, while in 1931 the value of imports of bacon was greater than that of wheat. The expenditures on the foods previously listed are given in Table 3.

TABLE 3.—*Expenditures on various food products* (5)

	1911-13	1924-26	1931
	000 £	000 £	000 £
Butter	24,346	50,378	46,358
Cheese	7,196	14,397	9,060
Fresh milk	3	32	54
Cream	35	431	748
Condensed milk	2,143	5,223	4,337
Milk powder	87	564	757
Eggs	8,651	15,810	13,768
Egg products	not available	3,348	2,884
Poultry	881	2,070	3,131
Bacon	15,483	40,770	33,136
Lard	4,142	8,939	5,911
Hams	2,905	7,891	3,217
Pork, frozen and salted	349	1,161	1,282

There is a decided falling off in expenditure on food in 1931 as compared with 1924-26. That drop took place between 1930 and the following year and was entirely due to the lower prices in these articles, as the figures on quantity imported reveal.

When the 1931 expenditure is compared with that of the average of 1911-13 the expansion is marked. Expenditure on imported butter increased by some twenty-two million pounds in that period, that on bacon almost eighteen million, on eggs over five, on poultry and condensed milk over two each, and on lard almost two. In 1931 the total expenditure on these listed products was £55,538,000 more than in pre-war days, leaving out egg products, for which no accurate comparison may be made. The next question is, who has reaped the benefit from this expansion?

Empire countries supplied the major portion of the increased imports of butter, furnishing in the pre-war period 848,000 cwts. and 4,000,000 cwts. in 1931, while foreign countries increased their supplies from 3,291,000 to 4,071,000 cwts. New Zealand and Australia absorbed most of the expansion, Russia and Sweden losing ground, while Denmark and Argentina expanded considerably.

Countries within the Empire still supply the cheese imported as they always have, the total from these countries increasing from 1,849,000 cwts.

in 1913, to 2,524,000 cwts. in 1931, while foreign contributions decreased from 448,000 cwts. in 1913 to 361,000 in 1931.

In bacon the reverse is the case. Empire countries increased exports from 250,000 cwts. in 1913 to 348,000 cwts. in 1931, although in 1927 the figure was 956,000 cwts. In 1913 foreign countries supplied 4,609,000 cwts. and 10,790,000 cwts. in 1931 or over 96% of total imports.

Denmark increased supplies from 2,335,000 cwts. in 1913 to 7,339,000 cwts. in 1931, but in the latter year Poland and the Netherlands each supplied over 1,000,000 cwts. and Sweden over half that amount, while Lithuania contributed more than the total of all empire countries. The United States was the only foreign country to decrease its supplies during the period, its contribution falling from 1,803,000 cwts. in 1913 to 189,000 cwts. in 1931. This decrease appears important and probably came about for largely the same reason that empire countries contributed less during that year than formerly, because alternative opportunities appeared more attractive. We shall refer to this point when discussing future possibilities.

The United States still retains the field in both hams and lard. In 1913 the trade in hams was 760,600 cwts. from the United States, 4,200 from other foreign countries, and a total of 855,000. In 1931 the figures were: United States 600,600 cwts., other foreign countries 140,100, total 831,100. The lard trade is more completely in the hands of the United States, the figures being: for 1913, United States 1,869,000 cwts., other foreign countries 51,800, and total 2,005,300; for 1931, United States 2,065,300, other foreign countries 211,700, total 2,548,900.

Considerably over half of the extra 22 million pounds spent on butter in 1931 as compared with 1913 has found its way to the countries within the Empire. These countries have also retained the increased expenditure on cheese, which has been small, amounting to only about two million pounds more in the latter year than at the earlier date.

Of the extra 18 million pounds spent on bacon in 1931 over that spent in 1913, foreign countries have absorbed practically the entire expansion in expenditure. The increased amount spent in the later year on eggs, poultry and condensed milk, amounting to another nine million pounds, has gone to foreign countries. It is impossible to show the actual percentages, but it is plain from a consideration of the quantities supplied that the major portion of the increased expenditure on these food products has gone to foreign countries.

Some modification of the values given for 1931 is necessary as the departure from the gold standard on September twenty-first of that year would have a tendency to increase the number of pounds spent on these products during that year. This is not a very important matter. Another qualification necessary is that of the re-exports of these products which amounts also to a small sum. More important perhaps than these considerations has been the difficulty of allocating European supplies to the countries of origin.

With all the necessary modifications amply allowed for, a comparison of the present time with pre-war days reveals some interesting facts. It is clear that Britain is spending much more on imported food at the present time than in pre-war days. The quantity imported has expanded during

that period. This expansion has been much more marked in some lines than in others. Imports of grain have remained practically stable, while those of some other products have expanded rapidly. Some of these products have been supplied chiefly by foreign countries.

While other markets were available for the surplus products of Canadian farms, no serious difficulty developed from dependence by Britain on foreign countries for food supplies. When the market for Canadian farm products faded in foreign countries, increased interest was awakened in intra-empire trade.

Recent expansion in British imports has not been in grain but in meat, dairy and poultry products. If advantage is to be taken of increased intra-empire trade by Canada, the marketing of grain in some form other than that of the raw product appears necessary. Herein lies the opportunity of increased trade within the Empire.

Part II.

INTERNATIONAL TRADE

A problem of vital interest to the industry of agriculture in Canada is that of international trade. While space will not permit a comprehensive discussion of this question, some brief survey appears necessary. Public regulation of trade is now quite general. Laissez-faire as a policy has very few advocates and almost no practitioners. Agreement or disagreement with the trend of the times in trade policies is a point which shall be omitted in order that space may be made for an analysis of trade regulations now prevalent.

What has been termed the collapse of credit (*6*) is blamed for the decrease in international trade. If this is placing the blame where it belongs then it is clear that had it taken place earlier, before debts became so gigantic, the difficulty would not have been so great. This is on account of the following series of principles which include: borrowings must be repaid, deferred, or cancelled whether they are domestic or international; payments must be made in goods or services, as what is borrowed is not money (gold) but credit, which is command over goods; if goods are not acceptable in return payment, debts may be either deferred, cancelled or repudiated. These simple truths appear to require endless repetition.

Overborrowing

The stage was all set for the credit collapse by international borrowing. Whether this was more the result of the desire for international credit on the part of borrowing nations or attributable to a greater degree to the desire of creditor nations to extend credit, we need not here discuss. What we are interested in is the result. That result will be more apparent at a later date, but already we may observe signs and portents revealing much.

The increased interest in international trade which must develop with increased international credit is probably responsible for the publication of a new volume termed "Europa" which sets forth the foreign trade of the past few years. In this volume the trade in merchandise for all the European

nations is tabulated. We find that of twenty European countries in the year 1928 only one exported more goods than it imported. All the other countries of Europe had an adverse trade balance in merchandise in 1928; that is, nineteen of the twenty countries imported more goods than they exported that year. And 1928 is said to have been a prosperous year. Certainly it was a prosperous time for those with goods to sell to find nineteen out of twenty countries on one continent ready to buy more goods than they wished to sell. This was indeed a rare opportunity—too good to last. There are quite a number of European countries where an adverse balance in goods is no uncommon thing; and so long as a condition such as this is more or less permanent, trade is not upset. In 1929—when international credit began to dry up—four of these same twenty countries exported more goods than they imported. This was indeed no very great change but might be taken as among the signs and portents by those interested in the phenomenon. In 1930, of twenty-one countries, nine recorded favourable trade balances in merchandise. The collapse of credit was becoming more apparent in that year. For 1931 reports are not as yet fully available. Figures for Europe at my disposal so far only include thirteen countries. Of these thirteen countries, however, five record a favourable balance of trade in merchandise.

As previously mentioned, more complete records will reveal a clearer picture, but from the information so far available is there any doubt about the trend? So-called good times are usually more or less dependent on and attributable to borrowing. Upon borrowed money there appears to be almost unbelievable expansion of imports possible. So-called bad times appear to be necessary to enable nations to repay—in goods—their obligations undertaken in more optimistic moments.

We must not be too hasty, however, in rushing to conclusions on this matter. So far we have been dealing with Europe only. There are some changes in the trade balances of other countries during this same period which may be of interest. In the year 1929-30, Australia recorded an unfavourable balance of almost six million pounds. The following year a favourable balance of nearly 28 million was recorded, while in the year 1931-32 this favourable balance reached over 40 million pounds (7). Other countries, among whom may be included New Zealand and Canada, have also recently converted an unfavourable balance to a favourable balance.

Generally the tendency has been, and naturally must be for debtor countries, from necessity when credit is not forthcoming, to sell more goods than they buy. Naturally all countries cannot do this. The result must eventually be for creditor countries—distinctly fewer in number—to increase their unfavourable balance in goods. In one particular case we find a creditor country with a favourable balance of trade. This reveals the dependence of some sections of the world on other sections in that a creditor country is expected to provide and may for a time, and actually did for a longer period than most students expected, provide both credit and goods. This condition also reveals the opportunity for debtor countries to continue to record favourable balances. This country may be thus forced to reduce first its supply of goods—its favourable trade balance—and second perhaps to join the other creditor countries in recording a regular adverse trade balance in terms of goods. This would appear to be necessary if solvency is to be at all general.

INFLUENCE ON GRAIN TRADE

The year 1928, when so many European countries were importing more goods than they were exporting, was a rare opportunity for those countries selling goods of the variety which Europe required. Prominent among the goods required by European countries are foodstuffs. Conspicuous among the goods imported by many European countries outside of Britain, especially when they have the credit, is wheat. In the crop year 1928-29 continental Europe imported 447 million bushels of wheat, a record quantity for the past decade and 175 million bushels more than was imported the following year when one fifth of the countries reported a favourable trade balance. The importations in 1929-30 were the lowest recorded during the past decade (*8*). The present season promises to approach this low record in quantity required, the ultimate result, however, remaining to be verified.

The reasons for the decline in the grain importations of continental Europe are well known. Importations of bread grains required large outlays during the post-war decade. As rehabilitation was accomplished and credit became more difficult to secure, the most vulnerable spot appeared to be a curtailment of national expenditures on imported grains. Hence governmental regulations were generally imposed to promote domestic production and prevent importation. These regulations have increased domestic production in Italy, Germany and other countries. Such regulations are expected to have a somewhat similar result in Britain.

It was argued by many that these governmental regulations were temporary, designed only to afford temporary relief to the grain grower and would soon be withdrawn. It depends on what meaning be given to the term temporary. Perhaps they will be temporary in the long view of the future. They have been in vogue now for a number of years and are still spreading, spreading sectionally to different countries and also spreading to include other farm products. Thus we are confronted with the question of whether the future trend is to be in the direction of greater self-sufficiency nationally or greater dependence on international trade.

EVOLUTION OF PROTECTION

The trend is unmistakably in the direction of a greater self-sufficiency nationally. How this has come about is not difficult to explain. How long this trend will continue is quite another matter. How has it developed? The chief difficulty with international trade at the present time is a disagreement over price. Specialization has many advantages but it necessitates a satisfactory exchange of the specialties when these are produced. International specialization has many of the advantages of specialization within a country but it appears to be difficult to secure a satisfactory arrangement over price between nations.

When we find countries specializing in the lines of activity which suit them best, we eventually have countries depending largely on a few goods which they produce for export. The importance of coffee to Brazil, sugar to Cuba, rubber to the West Indies, coal to Britain, and wheat to Canada are outstanding examples. To the producer the price, whatever it may be, is generally too low. When a country becomes largely dependent on

the export of one commodity, it is an easy matter to get the political machinery of that country interested in stabilizing the price. Coffee valorization has been attempted intermittently since 1905. Stabilization sometimes is difficult. When it fails, a bonus on exports is usually resorted to. Examples of this practice are so numerous that mention is scarcely necessary. Bonused exports sooner or later meet tariff barriers. It was for this particular emergency that anti-dumping clauses were evolved. This innovation, first adopted in Canada in 1907, has become pretty general since that time. Anti-dumping clauses were designed to combat not *free trade* but *unfair* trade. The difference between the anti-dumping clause and protection pure and undisguised depends upon how you define *dumping*—not a simple matter by any means.

These stages in the evolution of protection have been pretty well exemplified during the past few years. It would appear that until the world in general and nations in particular can arrive at some more satisfactory agreement as to the value of their special contributions in terms of other goods, a tendency to greater self-sufficiency must be expected. This will handicap trade in general and also international trade. The disadvantages entailed in such a trend may be relied upon to make themselves evident. This may be expected in the long run to make prices more effective in moving goods, the surprising thing being, however, how long this expected effect may be deferred. Apparently a spell of this self-sufficiency idea must be experienced before trade may be expected to expand to any very great degree. Those who are interested may well consider the discussion of this subject by Sir Arthur Salter in the special anniversary number of *Foreign Affairs*.

There is one point, however, that is frequently neglected in discussions of international trade. Many who lament over what is sometimes termed the collapse of trade consider only the *value* of trade. This means little unless the *quantity* is also considered. Many articles with which we are here interested have been consumed and traded in in greater quantities than during the so-called prosperous period prior to 1930. The interesting problem arises of how it would be possible to make business bad for some industries and some lines without some others reaping a corresponding benefit. If the trouble is only one of price, as so many maintain, then the disadvantage to the seller must be compensated for by a corresponding advantage to the buyer. This advantage to the buyer has already resulted in an expansion of consumption of some lines of food products and farm products, as has already been noted.

In the past, the prosperity of this country, and of the United States also for that matter, was broadly based upon the export of surplus farm products which Europe, with its dense population and comparatively high purchasing power, could absorb. The owner-operated farm developed here derived its revenue from various sources, including returns from actual farming operations, interest on capital invested, and enhanced land values. These several sources of returns have not been constant. Only fitfully, as in times of war or post-war conditions, has the farming business yielded a high reward. Yet when enhanced land values over long periods were added to returns from farming, the total sufficed to build up an effective demand for other goods.

For almost a century now—since the repeal of the corn laws in 1846 to be specific—surplus food products from the American continent have sought

the European market, which has been comparatively free. During that same period there developed on this continent, under various degrees of shelter and defence, other industries, few of which made any endeavor to compete in world markets and many of which grew to consider the supplying of the domestic market as not only their own particular private preserve but also the only market which they might hope to obtain.

While European countries, or other countries for that matter, were able and willing to afford sufficient outlet at fair prices for the surplus products of the farm, such a national organization was not only possible but gradually came to be looked upon as natural. Not only was this organization possible; it flourished to such an extent that older importing countries which formerly feared a scarcity of food found themselves confronted with a new danger from America and elsewhere—a food surplus. Importing nations began to defend themselves against this flow of food by embargoes, tariffs and quotas with somewhat disastrous results to the business organization of countries producing a surplus of farm products.

Purchasing power of farmers for other goods depended largely on profitable disposal of the surplus to importing countries. Present organization was built up to meet this demand. Any decline in this demand from overseas is promptly reflected in the following ways: lower domestic prices, lower land values, decreased purchasing power of the farming industry, and increased unemployment in other industries.

Endeavor by the farming industry to maintain its purchasing power and accustomed standard of living has led the farming industry to maintain its revenue as far as possible by increasing the volume of output. Up to a certain point this method of meeting the situation is both effective and commendable. It is certain, however, to increase the surplus. Competition in this instance reveals no immediate tendency to kill the goose which lays the golden eggs but rather increases its fecundity. But even this increased fecundity is unable to secure the desired effect. The surplus increases so rapidly that increased volume of output is unable to maintain the value of returns. The eggs are more numerous, but in some sections they are scarcely worth moving and in danger of becoming somewhat stale. Further, there is a question if this increased fecundity can be permanently maintained without loss of constitution and vigour of the goose. The goose maintains its fecundity, as is proven by the surplus on hand, but ample evidence exists of its somewhat emaciated physical condition.

It is clear that the volume of output is maintained at its present rate only by sad neglect of permanent improvements in plant, small provision for depreciation, and almost total lack of consideration of necessary reserve. The productive investment is not passing from weaker to stronger hands, as is the condition so frequently proclaimed by authoritative writers in regard to investment securities. The agricultural plant is remaining pretty largely in the same hands. These hands are becoming weaker financially, and improved conditions are essential to avoid partial paralysis.

Notwithstanding the expansion of food importations recently in some countries in response to lower prices and the stability of the industry of purveying food in general, the purchasing power of the farming industry is

not likely to be enhanced to such a great degree by food importations in the decade we are now entering as in the one just past. Increased land values do not offer much hope of making up this deficiency. If the purchasing power of the farming industry is essential to keep the wheels of other industries in motion, it may be necessary to canvass some other alternative. One possible alternative is a more even distribution of the rewards of effort in different domestic industries. When this alternative is seized, business may be expected to be more brisk.

Generally the demand for food products from Europe is not likely to be as great in the immediate future as it has been in the recent past. In some farm products recent importations have been expanding rapidly, as has already been noted. Wherein Canadian agriculture may take advantage of this expansion remains to be examined.

Part III.

THE OPPORTUNITY

A review of the trade between Canada and Britain in food products would lead to the conclusion that an opportunity exists of expanding exports, if and when import requirements can be met. Before jumping at this conclusion, more thorough examination appears not only warranted but necessary. The first question arising is, if this position is now unsatisfactory how and why has it developed? This question necessitates some reference to past history.

During the first post-war decade, the proportion of exports of farm products which found an outlet in Britain declined. This development came about from two important causes. These causes were the increased demand for foodstuffs from foreign countries and increased takings of other farm products by the United States. Both these markets have recently displayed an unmistakable tendency to decline. The decline has been brought about by public regulation. National self-sufficiency has become pretty general. How long this will continue is of course problematical. An authority from Europe has recently ventured this prophecy:—

"We have seen an immense amount of economic nationalism in the last few years and I do not doubt that in the next fifteen years there will be a great deal more of economic isolation."(*9*).

If this is a fairly accurate forecast, it would appear imperative to make necessary provision to secure for Canada as large a share as possible of the import market of Britain for farm products. To expand exports from Canada to Britain will be difficult for many reasons. Among them may be noted, first, the tenacity of those countries now supplying the market; second, the preference of Canada for following other types of farming; and third, the likelihood of lower profits from the export market than have recently prevailed in the domestic market for those farm products for which the British market has expanded.

Those who are already successfully in the field in supplying the British market have built up their position slowly but steadily. Some of them have no alternative available and some of them have borrowed money from

Britain. Trade follows investments rather than the flag in most cases. If goods are not taken in payment of debts then debts are simply deferred. We certainly have had this fact forced home in recent years.

Britain is more anxious at present to export goods than to loan money to food supplying nations. Where these foreign countries will not accept the goods in exchange for their products and cannot secure the loans, or do not need them, they must be content to lose the market—if some other country with a more pressing claim either in debt or goods can supply the market.

Popular Canadian Farm Products

The most popular, because the most suitable, farm products in Canada are grains. This is ever the case with pioneer countries. It required the adverse tariff of the United States against Canadian barley to establish the export bacon industry in Ontario and strengthen the cheese-export business in the last decade of the past century. Grain growers will, if compelled to do so, manufacture their grain into meat, eggs and dairy products if they cannot dispose of it directly. Compulsion is much more effective than advice, as calamity appears to be about the only medicine that most of us will take. The result is inevitable, requiring only the stimulation of a more or less permanent period of low grain prices. It may be more easy to modify the manner of disposal of grains than drastically to reorganize farming. Canada is destined to produce an abundance of small grains because these are adapted to the soil, topography, and climate as well as to the experience of her farmers. But just in what form these products may seek export markets is quite another question which will be later discussed.

Future Prospects for Grain Export

During the past decade Canada did particularly well in the export of farm products, and this while, as we have noted, the hold on the British market was weakening. In one year the excess of exports over imports of farm products reached almost half a billion dollars. During that decade, however, Canada came perilously close to going off the world market in bacon, butter and eggs, the very products in which British imports have expanded most. In fact, during recent years domestic prices of these products have been at times materially above the prices which would have prevailed had these products been on an export basis. So long as surplus grains may be disposed of without difficulty such a condition causes no alarm. But then was then, and now conditions have altered.

Canada is particularly fortunate at the present moment in that it has considerable quantities of grain for export rather than depending entirely on the export of copper, nickel, motor cars, machinery or even news-print. The demand for food products, though not particularly elastic, is fairly stable. Canada is just as fortunate in that it has not depended entirely upon farm products recently but has had the diversity of newsprint, gold, minerals and manufactured articles to supply that diversity which makes for national stability.

No one doubts that the natural resources and ability to produce a surplus of bread grain will continue to be a source of national prosperity. The demand for these products is increasing, but momentarily not as rapidly as the supply.

The capacity for increasing the supply appears to be great at the present time. The demand is at least temporarily slackened by governmental regulations, which are resulting, and will result, in increased production in importing countries.

Transforming the Surplus

The necessity, therefore, appears to be, for the present at least, to seek some other method of marketing surplus grains than in the raw form. A considerable quantity of the wheat grown on this continent during the last two years has been transformed into other products—eggs and meat—before seeking a market. The possibility of storage, combined with alternative methods of marketing through transforming wheat into other things that are in greater demand in the market, prevents the price from going lower than it otherwise might. If production continues to expand faster than consumption in the raw form, a greater proportion of this grain will of necessity seek the market by this indirect, laborious and leisurely, but frequently more profitable, route.

Other grains appear to have a less attractive future in the export market as raw products than wheat. Britain consumes now less than half the quantity of beer of pre-war days, and one of the latest laments over underconsumption has been that of the brewers. This will not be taken very seriously in some quarters, but the net result will no doubt be the lessening importance of barley as an item in international trade.

For the ten months ending May 1931, Canada exported over ten million bushels of barley for less than four million dollars, the price being 36.5 cents per bushel. For the ten months ending May 1932, nearly eleven million bushels brought four and three-quarter million dollars, the price being 43.75 cents per bushel (*10*). It does not appear a very difficult task to get more out of this grain by transforming it into some other form before marketing.

Oats is a more important and generally grown grain than barley in this country. This grain does not enter into international trade in the raw form to any very great extent except during abnormal times. The adaptability of this crop is remarkable. It is about the only grain crop which is grown extensively in all the provinces. It is just as accommodating in the uses to which it may be put, in that it furnishes the grain hay of the western provinces and the foundation of the ration for meat and milk in all districts. There is small difficulty in finding alternative uses for oats, yet some people endeavor to sell it as a cash crop. The present price at Fort William for No. 2 C.W. is 24.1 cents per bushel (*11*).

The adaptability of the bulk of the farm land in Canada to the production of small grains is conceded. There is no alternative for a great portion of the western provinces where grain hay is the chief forage crop. Production must continue to be grain. The problem then resolves itself into a change in the form in which this grain is sent to market rather than a change in the system of farming. There is a machine which is so far unequalled for transforming surplus grain—which apparently is not wanted—into a product which happens to be the very one which has shown the greatest expansion in British importations of food products in recent years and which has also been the product supplied by foreign countries. That machine is the pig.

Bacon as a By-Product

Canadian farmers have started so frequently in the business of raising hogs and given up so promptly when profits were disappointing that it is with some hesitancy that this subject is again broached. There is, however, still much that may be said on this subject. First let us repeat what we have already pointed out, that the expenditure of Britain on bacon alone in 1931 was almost eighteen million pounds more than in pre-war years. Further, in 1931 foreign countries supplied 96% of the quantity imported.

With a preference in the British market available, and a quota of up to 2,500,000 cwts. allowed, and realizing the ability of the pig to transform an unwanted grain surplus into a product in demand, now would appear to be a better time to start and stay in the business than has earlier appeared.

But one thing must be distinctly understood and that is that the preference in the British market depends upon two things—and this comes directly from one of the leading importers of bacon, a firm which handles from 25 to 30 thousand sides a week and has around 300 employees handling bacon on a wholesale basis—namely, *uniformity* and *regularity* of supply. This means that it is necessary to stay in the market even when profits are non-existent in order to retain that market when profits are possible.

To recapture the bacon market of Britain will not be easy. At an earlier date the Danes were driven from the German market by a prohibitory tariff. They canvassed the situation and transferred their attention to supplying the demands of the British in butter, bacon and eggs. During the World War their hold on this market was dislodged temporarily, and Canada and even China made important contributions during that period. During the last decade Denmark gradually regained control, notwithstanding the fact that two-thirds of the concentrates fed in Denmark are imported. Now German tariffs are more forbidding than in the earlier period. Tariffs in other countries are no more easily overcome. A British tariff threatens, but there appears no alternative market to which the Dane may transfer attention. Under such conditions, Denmark is likely to hold on to the British market very tenaciously.

Other countries have recently displayed an interest in the British imports of this product. Poland, by virtue partly of a bonus on exports, has built up a trade which in 1931 amounted to a million cwt., the same quantity as Holland contributes, while Sweden exported half that quantity and Lithuania contributed more than all Empire countries in that year.

The quality of the product of these various countries is of a varied nature, judged by the prices which for 1931 ranged as follows (*12*) (Table 4):

Table 4.—*Wiltshire prices on the British market.*

	Price per cwt. Av. 1931	
British Wiltshire	95s.	9d.
Irish	90	9
Danish	63	9
Swedish	59	0
Dutch	57	0
Polish	50	6

This difference in price emphasizes the importance of quality. At the same time it reveals the opportunity of Britain producing more domestic bacon on account of the advantage of price. This possibility has been realized, and Britain plans on feeding more hogs at home in the future. Recommendations are that pig raising should become more general on individual farms and also that some specialists should devote attention to "mass production" of hogs.

There appears to be one place where mass production of hogs is particularly appropriate if it can be carried on successfully anywhere. That place is in Canada in proximity to the grain elevators, where all grades of grain are concentrated, including the screenings which are sometimes unsaleable and frequently quoted at 50 cents per ton. Perhaps screenings at that price, and even the lower grades of feed grain, might be salvaged by hog feeding at these elevators if mass production of hogs is feasible anywhere.

This word "salvage" is the one to use in connection with hog feeding anywhere. Production of bacon, if considered as an alternative method of marketing grain a way of salvaging what might otherwise be lost—should be more profitable in those sections producing a surplus of grains than in those importing feeds. And further, those sections of the country where surplus grain exists are the logical areas where this business should be and eventually may be, expected to be carried on. The opportunity of taking a more prominent place in the British bacon market is peculiarly applicable to the grain growing sections of Canada.

Unfortunately, Western Canada, which at the present time furnishes the surplus pork products of the Dominion, and which, by virtue of being the surplus area of grain-production is the section which might secure the greatest benefit from the British preference in this commodity, does not produce the type of product popular in the British market. This has been pointed out elsewhere and is only mentioned here as one of the difficulties which must be overcome if we are to realize the potentialities of this market to the full.

Another difficulty in connection with this development is the cost of processing and marketing of farm products after they are grown. During the month of February 1932 the retail cost of the weekly family budget for food in Canada was $7.34, exactly the retail average for 1913, this only by virtue of the fact that articles purveyed most directly by farmers, such as butter, fresh pork and potatoes, were so much below the 1913 retail price that the average for all foods was exactly the same, notwithstanding the fact that prices of bread, milk, and sugar were higher than the 1913 price. Those articles coming more directly from the farm and thus meeting more intense competition were below the 1913 level, while those foods requiring considerable processing and purveyed by organizations having greater influence over price were higher. It is similar with grains processed into meats and dairy products. From the time the animal leaves the pen or the raw material leaves the farm, these products are handled by high priced labour and expenses mount alarmingly. Farmers can and do compete with the world successfully in producing grain and other raw products. Farmers work for less reward than labourers in other industries, more particularly when they are working for themselves. Products which are processed by high priced labour are not so easily placed on the market in competition with the world.

This inequality in the reward of effort in different industries is the major reason prolonging the bad times. This has been pointed out before (*13*) and is now quite generally conceded (*14, 15*). This difference may make it hard to compete with the world in products requiring much processing. If this difficulty is not overcome, then it may be necessary to confine our attention to the export of raw products only and continue to carry on expecting, as has been the case in the recent past, farming to be practically the only industry to meet world competition. In that case probably there will be an opening for marketing a greater proportion of grain for feed in the British Isles where a programme for increased bacon production is now being arranged.

Prospects for grain export depend greatly on the numbers of live stock on hand to consume the grain. The number of hogs bred has a special influence on the demand for grain on account of their capacity as grain consumers. Much valuable work has been done on what are termed hog cycles both here and elsewhere, as instanced by recent reports (*16*). It is generally conceded that there is a tendency for the hog population of different countries to expand and contract in response to price. There may also be constructed a world cycle of hog production in response to price. In 1930 the world was faced with surplus grain and a smaller than usual hog population. At present the hog population is greater than it was two years ago, and this should no doubt have an important influence on the amount of grain consumed.

The hog cycle, like many other things, is not exactly what it used to be. The world hog cycle may not be just exactly that of some individual countries. An instance of this is presented by the fact that Denmark increased its hog population almost one year before the increase occurred on this continent in the last upswing in numbers.

Again, the hog cycle may not be exactly the same in different sections of the same country. Careful study of the numbers of hogs in the different provinces of Canada, for instance, will reveal that the different provinces do not always increase or decrease their hog population at one and the same time or at the same rate. Naturally such uniformity of procedure is scarcely to be expected. If and when Quebec using purchased feeds decreases its number of hogs while Alberta at the same time increases its numbers, no surprise is occasioned. But when the three prairie provinces, where feed is abundant, do not always move at the same rate or in the same direction, as happened during the past decade, then it proves that discussions of hog cycles, in order to be accurate, must state very clearly the territory included.

With these points in mind, we find it very difficult to fit present scrappy information into the logical sequence of a world hog cycle. "According to Hoyle" we should be at present near the peak in world hog population. Some countries apparently have passed the peak. The information to hand is somewhat scrappy, yet what is available is presented in Table 5.

TABLE 5.—*Number of hogs.*

	1930	1931	1932
Canada (*17*)	4,000,000	4,716,720	.....
U. S., Jan. 1 (*18*)	55,301,000	54,374,000	57,511,000
Germany (*19*)	19,800,000	22,500,000	21,300,000
Denmark (*20*)		5,442,000	5,457,000
Northern Ireland (*21*)		235,672	219,767

The total hog population for Canada is not yet available for the present year. If marketings are any criterion the increase still continues, as 37 weeks total for 1932 was 2,222,799 as compared with 1,694,354 for a similar period during the previous year (*22*). The numbers reported for the various countries are not secured at the same period of the year and thus are not strictly comparable. Yet sufficient data are here presented to show that all countries are not moving in the same direction at the present time. Germany already records a pronounced decrease. This has been the leading country in maintaining high grain prices. Other countries have followed this lead and while various ingenious methods have been adopted to secure a high price for the grain grower who sells his grain and at the same time secure cheap feed grains for the feeder depending upon purchased concentrates, profits have generally been lacking during the present season on purchased concentrates. On this account declining numbers of bred sows have been reported from Denmark, Holland, Poland and Sweden, although total numbers, where available, do not as yet show any aggregate decline.

The decline for Northern Ireland is given here, partly on account of the accuracy of the figures where each farm is visited annually by the provincial police and the numbers recorded. Further, for the reason that the decline in numbers is smaller than the difference in price and profits would suggest which is explained by the fact that there, as in other parts of the United Kingdom, the stage is all set for a great expansion in pig raising in anticipation of the governmental assistance expected.

Another point to reckon with is that recently many European countries besides Denmark have sought a share of this market. Poland, the second largest exporter in 1931, bonuses the export of this product. Other countries such as Holland, Sweden and Lithuania, having made such phenomenal progress recently, cannot be expected to give up the position without a struggle, while the loathness of Denmark to decrease its supply even while losses are incurred reveals its tenacious hold on this market.

The extent to which Canada may benefit from this opportunity will then depend upon many factors, including the capacity of the western farm both to produce the type of bacon the market demands and to feed hogs cheaply enough to make possible a profit greater than may be obtained by marketing grain in other ways.

In addition to this influence will be the degree of mutual assistance and cooperation extended by those who transport, process and market the product in the more concentrated form. This business will only be established against the competition now prevailing in other countries on the foundation of cheap labour and low profits. The farmer should not be the only interested individual expected to work for small returns for the sake of future national benefit.

Salvaging Unsaleable Grain

The year 1930 recorded the lowest number of hogs marketed in Canada during the past ten years. During that year Canada came perilously close to being on an import basis for pork products, exporting about twenty and a half million pounds and importing over nineteen and a half million, leaving

a net export balance of 843,755 pounds (*23*). During this period and part of the following year the domestic price was above the world price prevailing.

Since that time a fairly rapid increase in production has occurred. This has taken place to a much greater extent in the grain growing provinces than elsewhere. The figures are most interesting. In 1931 Canada increased the number of hogs marketed by 343,000 over the previous year. Alberta provided 94,000 of this increase, Saskatchewan 84,000, Manitoba 69,000, Ontario 67,000 and Quebec 29,000. The three grain growing provinces accounted for almost 72% of this increase.

Marketings of hogs in Canada during the first eight months of 1932, when compared with the first eight months of the previous year, show an increase of 629,740, consisting of a gain of 268,390 in Alberta, 193,168 in Ontario, 138,736 in Saskatchewan, 41,126 in Manitoba and a decrease of 11,680 in Quebec (*24*). Almost exactly 71% of this increase has been provided by the grain growing provinces.

This is what might be expected and, under present conditions, what must develop. Hogs may be fed most cheaply where grain is grown. In Quebec province, where the major portion of feed must be purchased, a decrease in hog feeding is already in evidence. The endeavor to secure the market in the east for western grown feed grain by a duty on corn has already been effective, effective not in increasing the market for grain in the eastern provinces but rather in making more secure the Quebec market for pork products from the grain growing provinces. This may not be an unmixed evil and at any rate is not the main point in this discussion. The chief point is that the grain-growing provinces have the same advantages over some of their competitors in the British bacon market that they have over Quebec, and for the same reason.

Tenacity of Competitors

Western Canada is the section which may secure the advantage from the export bacon trade and for this reason. The expansion of hog feeding in Canada during the past two years proves that the section in which to feed hogs is where grain is plentiful, cheap, and difficult to move as grain; and that the first sections to give up in the struggle to make money feeding hogs will naturally be those which depend on purchased feeds. This is made clear by the present trends in the prairie provinces and Quebec.

Even with hog prices as low as they have recently been, feed in the prairie provinces has been lower. Therefore all that the hog feeder could lose in feeding hogs was the labour in looking after them. On the other hand, where grain has to be imported long distances, there has been a good chance during the recent months for the hog feeder not only to go unpaid for the labour of feeding hogs but also to lose some cash as well. It is reported that this is just exactly what has been going on in Denmark where two thirds of the concentrates fed are imported. The decrease in numbers in Quebec indicates that similar results have been met with there.

The Danes may be expected to continue feeding hogs in the face of actual losses with greater persistency than some other peoples for three main reasons:—

1. Alternative opportunities may be less attractive;
2. Reluctance to relinquish a business formerly prosperous;
3. Realization of the necessity of maintaining a regular supply when profits are temporarily impossible.

No market for Danish farm products more attractive than catering to the British breakfast appears on the horizon at the moment. For this reason it may be expected that supply will be kept up even though prices and profits are lower than those prevailing during the past decade when this supply expanded so enormously. The supply will be maintained, as the Danes realize the necessity of keeping supplies regular even when there is no profit in the business in order to be certain of the trade when it is profitable. This is exactly the point which has not been fully realized and acted upon in Canada up to the present time. In many other farm products as well as bacon attention has been switched from one market to another according to whichever opportunity proved the most inviting. Repeatedly the market in Britain for meat and dairy products as well as bacon has been expanded and relinquished, until today all sources of information insist that the two essential requirements for farm products from Canada in the British market are uniformity in grade and regularity in supply.

Poultry

Importations of eggs into Britain remain approximately around the pre-war level. Considerable expansion in consumption is recorded, but domestic production, expanding during the past half of the last decade at about 4% annually, has brought the domestic production to an estimated total in 1931 of about 29 million great hundreds. Consumption is reported at around 140 eggs per capita annually. Importations, during the year 1931, were 25,920,000 great hundreds, and, of these, 6,137,000 were from Empire countries and 19,783,000 from foreign countries (*25*).

There has been considerable shift in sources of supply of eggs since pre-war days. In 1913 Denmark supplied 4,265,000 gt. hds. and 7,548,000 in 1931. The Netherlands strengthened their position slightly during this time. Russia, the chief source of supplies in 1913, partly perhaps through including part of Poland at that time, almost ceased to be a factor in the trade. France, Italy, Austria-Hungary and Egypt almost dropped out, while China, Australia, South Africa and Canada appeared in the market.

The quality of the eggs imported into Britain, as reflected in the price, reveals the opportunity for increased domestic production (Table 6).

Table 6.—*Eggs, average prices, London* (*26*).

	1931
English	15s 9d per 120.
Irish	13 1 "
Danish	12 3 " "
Polish	8 1 " "

Imports of dead poultry have expanded recently and the 1931 total was the largest both in quantity and value, showing a gain of 97,000 cwts., or 17%, over those of the previous year. The total quantity of 667,000 in 1931 compares with 262,000 cwts., the average of the two latest pre-war years.

The value of dead poultry imported last year was £3,131,000 as compared with £881,000 in the pre-war period.

The increase in expenditure on imports of dead poultry has been largely absorbed by foreign countries. From 1913 to 1931, countries within the Empire increased their contribution from 1,000 to 112,300 cwts. Of this total, the Irish Free State supplied 109,100 cwts. in 1931. Other Empire countries, including Australia, Canada and South Africa, sent 3,200 cwts. Britain draws supplies of dead poultry from all continents, the leading contributors in 1931 being Russia and Hungary which together supplied about one-third of the total. Importations in 1931 established a record both for volume and value, poultry being the only line of farm products selling, in that year, above the prices prevailing before the war. The 1931 price of poultry was almost exactly 40% higher per cwt. than in 1913.

Exports from Canada increased from 300 cwts. in the two pre-war years, 1912-13, to 500 cwts. in 1931. Judging from the position occupied in the list of countries supplying this trade, there would appear to be an opportunity of converting some portion of the excess supply of small grains now on hand into a product which is still in considerable demand in spite of a price much above the pre-war level. This brings us to the question of future prospects.

Future Prospects

So long as foreign countries continued to absorb grain at an increasing rate and satisfactory price, the British market for other products was neglected. Now that foreign countries have expanded domestic grain production and require less grain from Canada, new interest is displayed in the British market. It appears the only attractive alternative at the moment. Yet necessary as it now appears, this alternative should not be regarded merely as a temporary escape from present difficulty. It should also be examined with regard to its possible permanent value. The question arises as to what avenue affords the most attractive future outlook for marketing grain. Will it be in marketing grain as grain or converting as much as possible of it into other products?

Upon this question significant developments of the past decade have an important bearing. Among these developments the following demand consideration:—

1. Expansion in grain production has outrun demand.
2. Recent trends are toward increased self-sufficiency and less international trade.
3. The outstanding exception to this world-wide trend is the food imports of Britain.
4. Imports of breadstuffs have remained almost constant since pre-war days, while imports of dairy products, meats, eggs and poultry, and fruits have expanded rapidly.

The best prospect for securing a reasonable return for grain for which there is no great need would appear to be to convert as much as possible of it into products that are in greater demand. This method appears to be the only hope of getting rid of the surplus of grains which is at present burden-

some. This alternative method of marketing is being followed in a fairly large way in different sections of the world at present. The feeding of wheat is credited with having amounted to roughly 100,000,000 bushels annually above the usual quantity in the United States during the past two years (*28*). The German government has disposed of 2,750,000 bushels of wheat to the manufacturers of chicken feed at a slightly reduced price from that reported in September prevailing in that country of $1.43 per bushel (*29*). This method might not be capable of absorbing a large proportion of the present surplus, but as an alternative method of marketing the lower grades of feed grains would appear to be much more profitable in the long run than storing them.

There are three methods of handling a surplus of grains which may be carried over from year to year. One is a reduction in acreage. This is the effective method of dealing with potatoes, largely a domestic, semi-perishable crop. The success of this method is evidenced by the results of the present season. Reduced acreage does not appear popular in the wheat growing sections of Canada, the present season recording increased acreage even when the government had to finance the provision of seed for millions of acres.

Another method of handling the surplus is to store it. This may develop into quite an expensive operation. A third alternative is to convert some of it into products which the market will take. This method of feeding is being resorted to recently to a great degree. The year 1930 found agriculture somewhat out of balance in regard to the amount of grain on hand as compared with the number of meat animals available as an alternative method of marketing grain. That balance is being restored and on this account the grain surplus is more likely to disappear. If more grain—even including wheat—is disposed of through conversion into eggs, meats and dairy products —products which are expanding in consumption at present prices—the price of grain in its raw form will soon show some improvement.

Summary

1. Food imports of Britain have expanded enormously since pre-war days.
2. Judged by volume of business, supplying Britain with food is the nearest approach to regular employment appearing on the horizon at the moment.
3. The business of supplying Britain with food is carried on by many countries outside the British Empire.
4. Some of these foreign countries are endeavoring to dispose of surplus food in Britain while rigorously excluding British goods and also food products from other Empire countries.
5. Increased intra-empire trade has become a necessity.
6. The expansion of British food requirements has taken a decidedly different direction during recent years.
7. Imports of breadstuffs have remained almost stable while imports of meats, fruits, dairy products, eggs and poultry have expanded materially.
8. Products of grazing lands are pretty well supplied by Empire countries of the southern hemisphere.
9. Dependence upon foreign countries for imports of bacon, eggs and poultry products has recently increased.

10. British imports of grain have not expanded, while European markets outside of Britain have become somewhat inaccessible.
11. Conversion of grain products into some form at present in greater demand in the market is now essential.
12. Herein lies the opportunity for Canadian agriculture in increased intra-empire trade.

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STUDIES OF METHODS FOR THE ISOLATION OF FUNGI FROM WHEAT ROOTS AND KERNELS[1]

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Introduction

These studies were undertaken with a view to determining effective methods of treating diseased wheat roots and seeds which are to be plated on agar for the purpose of isolating fungi. The ideal method aims at the complete removal of surface contaminants without affecting internal fungi. The studies have shown, incidentally, that several of the methods are suitable for preparing sterile wheat seedlings for inoculation tests.

A Review of Methods used by other Investigators

An exhaustive review of all the methods used by other investigators was not attempted. Instead, an effort was made to obtain papers which dealt particularly with the problem under investigation. From these papers, suggestions were obtained dealing with various techniques for treating plant fragments and seeds from which isolations were desired. Some of the papers also suggested methods of treating seed to provide sterile seedlings for inoculation work.

Methods used for Plant Fragments

Mercuric chloride dissolved in water (1:1000) was used by Apostoloides (*1*) and Edgerton, Tims and Mills (*7*). The former was plating pieces of diseased sycamore leaves, the latter, roots of sugar-cane infected with a *Pythium* root rot. The periods of treatment did not exceed one minute, and sterilization was followed by rinsing in sterile water. Henry (*8*) also used the same method of sterilizing pieces of wheat roots and stems. Simmonds (*9*) reports satisfactory results with sterile water in a "washer". That method was used regularly in isolating fungi from roots and stems of cereals.

Methods used for Seeds

Solutions (1:1000) of mercuric chloride in water were used by Atanasoff (*2*), Henry (*8*), and Crawford (*6*) in sterilizing portions of wheat heads, wheat seeds, and cotton seeds respectively. The period of treatment was 2 minutes and sterilization was followed by rinsing in sterile water. An alcoholic solution of mercuric chloride (2 grams in 1000 c.c. of 50% alcohol) was used by Chen (*4*). Pre-soaking of many kinds of agricultural seeds in water for 10 or 12 hours preceded sterilization, and rinsing in 93% ethyl alcohol, and in sterile water, followed it. His periods of treatment were from 2 to 5 minutes. Formaldehyde vapour, as used by Thomas (*10*), checked the growth of surface fungi on many agricultural seeds. The vapour was passed along with steam and compressed air over the seeds. Chih (*5*) charred wheat seeds over an open flame after soaking them in 70 per cent alcohol for 2 or 3 minutes. Washing of seeds in sterile water in a "washer" was found by Simmonds (*9*) to be a satisfactory general method.

[1] Paper read before the Canadian Phytopathological Society, Guelph, Ontario, June, 1931. Contribution from the Division of Botany, Experimental Farms Branch, Dominion Department of Agriculture, Ottawa.

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Methods used to obtain Sterile Seedlings

The methods used here aimed at complete sterilization without injury to the seed. After germination sterile seedlings were selected. Silver nitrate (1–100 normal), followed by an NaCl solution, alcohol, or sterile water was used on wheat seed by Henry (*8*). Calcium hypochlorite, as reported by Wilson (*12*), gave good sterilization of wheat seeds after 15 hours and the seedlings were not injured unless the time of treatment exceeded 20 hours. Mercuric chloride in water (1:1000), preceded by soaking in a lime solution, and followed by rinsing in sterile water was used by Valleau and Johnson (*11*), in securing sterile corn seedlings.

Material and Methods

Before freeze-up in the fall of 1930, some Marquis and Kubanka wheat stubble with roots was obtained from the field. The surplus soil was shaken from the roots and they were spread out on a greenhouse bench to dry, care being taken to prevent exposure to strong sunlight. The seed which was used for these tests was from a sample of Marquis wheat grown at Colonsay, Sask., in 1927. A greenhouse test of this seed, in sterile sand, gave 95.9% germination and 7.3% showed lesions, practically all of which yielded *Helminthosporium sativum*. Acidified 2% potato dextrose agar was used throughout the tests. The dried roots were washed thoroughly under a tap and as many pieces as possible, which showed lesions, were cut from the material by means of sterile scissors. The treatments were done immediately and the pieces of root were plated on agar in petri dishes, with five pieces in each dish. Fifty pieces were used for each treatment. The seeds were not soaked or washed prior to treatment but in two series they were dipped in alcohol or in a saponin solution for the purpose of facilitating wetting. Ten seeds were put in each petri dish. One hundred seeds were used in each series and all of the plates were incubated at 24.5°C.

The various methods of treatment which were used were as follows:

(1) Soaked in a 1:100 water solution of saponin for 10 minutes and rinsed in sterile water.

(2) Soaked in a 1:100 solution of saponin in 50% alcohol, for 5 minutes, and rinsed in sterile water.

(3) Soaked in a 1:1000 water solution of mercuric chloride for 5 minutes and rinsed in sterile water.

(4) Pre-dipped in 50% alcohol, soaked in 1:1000 mercuric chloride for 10 minutes and rinsed in sterile water.

(5) Soaked in 1:1000 mercuric chloride for 10 minutes and rinsed in sterile water.

(6) Soaked in a 0.2% solution of mercuric chloride in 50% alcohol for 1½ minutes, rinsed in sterile water.

(7) Soaked in 1–100 normal silver nitrate for 20 minutes, rinsed in sterile water.

(8) Soaked in calcium hypochlorite (10 grams commercial chloride of lime to 140 c.c. water) for 20 minutes, rinsed in sterile water.

(9) Soaked in hydrogen peroxide (laboratory strength, about 3%) for 20 minutes, rinsed in sterile water.

(10) Washed in 6 changes sterile water in the "washer", (*9*).

(11) Pre-dipped in 50% alcohol; washed in 6 changes of sterile water in the "washer".

(12) Pre-dipped in 1:100 water solution of saponin; washed in 6 changes sterile water in the "washer".

(13) Washed in a sterile water solution (0.05%) of saponin in the "washer".

(14) Pre-dipped in 1:100 solution of saponin in 50% alcohol; washed in 6 changes sterile water in the "washer".

(15) Dry heat, 100°C for 17 hours.

(16) Hot water treatment as for loose smut. (4 hours at room temp.; 2 minutes at 120°F; 10 minutes at 129°F).

Daily records were kept for nine days and the total number of fungi growing from the pieces of root or from the seeds noted each time. At the end of the nine-day period, the fungi were classified as light or dark, and the number of each kind noted. *Rhizopus* colonies developed in a few cases from the material and their number was listed separately. In addition to the fungi growing from the seed, its daily germination for a period of four days was observed. By the end of that time, germination was complete.

Isolations from Wheat Roots

The data obtained by sterilizing or washing pieces of Kubanka and Marquis roots, and plating them on agar are presented in Tables 1 and 2 and Figures 1 and 2.

It is evident that a great deal of the mycelium on or within the pieces of root which were treated with silver nitrate and mercuric chloride solutions was killed. Many of these pieces produced no fungi, whereas each of the pieces which were "washed" or treated with hydrogen peroxide or calcium hypochlorite yielded at least one colony, and, quite frequently, three. Kubanka roots produced more fungi than Marquis roots in all treatments except one, and considering the small number of pieces used for each treatment, there was considerable correlation between the results for the two kinds of wheat roots.

Table 1.—*The number of colonies of fungi obtained after treating Marquis and Kubanka wheat roots and plating them on agar in petri dishes. The results given are percentages of the number of pieces plated.*

No.	Treatment	Time in minutes	Per cent fungi	
			Marquis	Kubanka
1.	1:100 water saponin	10	184	252
2.	1:100 alc. saponin	5	86	150
3.	1:1000 mercuric chloride	5		100
4.	Pre-dip alcohol, 1:1000 mercuric chloride	10	36	56
5.	1:1000 mercuric chloride	10	66	26
6.	.2 per cent alc. mercuric chloride	1½	84	100
7.	1:100 N. silver nitrate	20	4	24
8.	Calcium hypochlorite	20	144	188
9.	Hydrogen peroxide	20	200	232
10.	Washer		166	222
11.	Pre-dip in alcohol; washer			194
12.	Pre-dip in water saponin; washer		184	244
13.	Weak saponin in the washer			216

TABLE 2.—*The effect of surface sterilization and washing on the rate of appearance of fungi from wheat roots, as revealed by the number of colonies present each day. The numbers given are percentages of the number of pieces plated and the treatment numbers are as in Table 1.*

Material	Treatment	Days								
		1	2	3	4	5	6	7	8	9
		Per cent fungi								
Marquis roots	1	..	76	148	166	182	184	184	184	184
	2	..	24	54	68	78	86	86	86	86
	4	..	2	12	22	30	36	36	36	36
	5	..	4	30	38	46	52	54	60	66
	6	..	4	30	52	66	70	74	78	84
	7	..	..	..	..	..	..	..	4	4
	8	..	44	92	116	132	144	144	144	144
	9	4	40	68	94	108	110	110	110	110
	10	2	98	102	136	166	166	166	166	166
	12	22	90	140	174	184	184	184	184	184
Kubanka roots	1	..	88	156	176	230	238	244	252	252
	2	..	26	82	112	124	132	142	148	150
	3	..	20	44	62	74	82	92	94	100
	4	..	2	14	22	42	46	48	52	56
	5	..	..	4	4	12	14	14	18	26
	6	..	26	54	68	80	88	94	98	100
	7	..	..	4	6	8	16	16	20	24
	8	2	80	132	162	170	186	188	188	188
	9	..	74	154	180	198	212	228	232	232
	10	..	88	130	180	212	218	220	222	222
	11	2	66	100	156	174	192	192	194	194
	12	22	86	158	190	206	220	234	244	244
	13	..	68	134	176	190	210	214	216	216

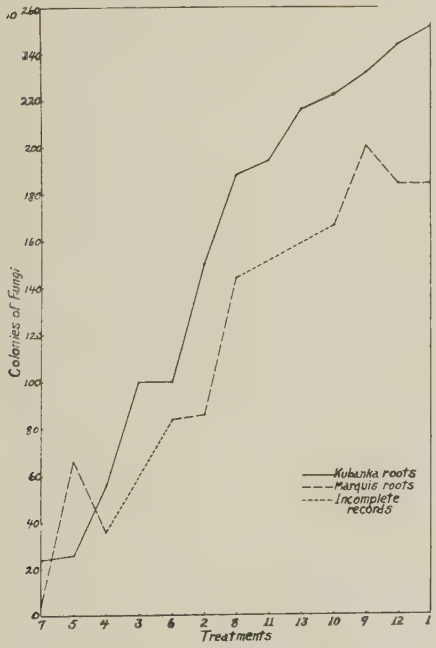

Figure 1.

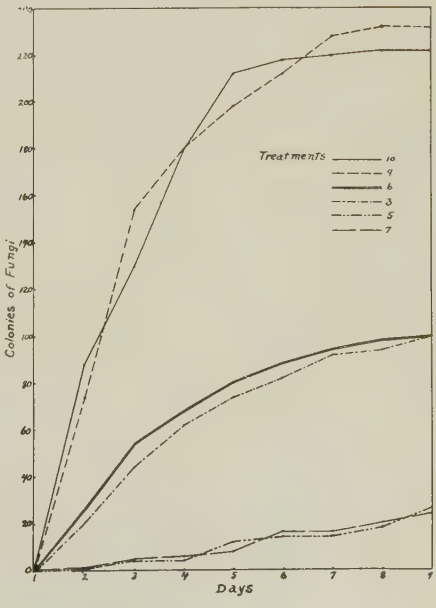

Figure 2.

Figure 1. The number of colonies of fungi which developed from Kubanka and Marquis wheat roots after they were treated and plated on agar in petri dishes. Treatments are the same as in Table 1.

Figure 2. The rate of appearance of colonies of fungi from Kubanka wheat roots which had been treated and plated on agar in petri dishes. Treatments as in Table 1.

TABLE 3.—*The germination and number of colonies of fungi obtained by treating wheat seeds and plating them on agar in petri dishes.*

No.	Treatment	Time in minutes	Germination at 4 days in per cent	Days								
				1	2	3	4	5	6	7	8	9
				Per cent fungi								
5.	1:1000 mercuric chloride	10	78	..	1	1	3	3	11	12	12	12
6.	.2 per cent alc. mercuric chloride	1½	78	..	..	..	4	5	8	8	10	10
7.	Silver nitrate	20	75	..	1	1	1	2	4	4	5	5
8.	Calcium hypochlorite	20	76	..	6	30	42	48	52	52	52	52
9.	Hydrogen peroxide	20	82	..	13	86	124	130	136	137	137	137
10.	Washer		71	..	17	52	63	76	79	80	85	85
11.	Pre-dip in alcohol; washer		76	..	2	9	20	21	36	39	47	47
13.	Weak saponin in washer		76	..	14	28	43	51	58	68	75	75
14.	Pre-dip in alc. saponin; washer		80	..	3	7	18	32	57	73	76	80
15.	Dry Heat 100°C	17 hrs.	26	..	..	3	11	14	16	19	19	19
16.	Hot water as for loose smut		37	..	2	10	11	11	11	11	11	11

Figure 3. (above). The germination and number of colonies of fungi produced by Marquis wheat seeds which were treated and plated on agar in petri dishes. Treatments as in Table 3.

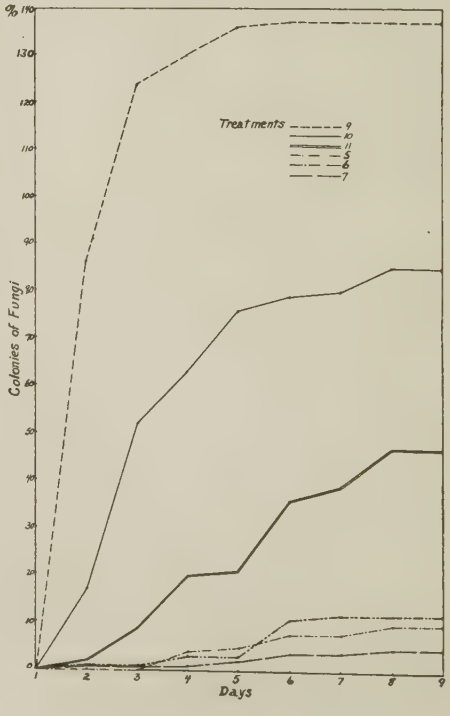

Figure 4 (right). The rate of appearance of colonies of fungi from Marquis wheat seeds which were treated and plated on agar in petri dishes. Treatments as in Table 3.

The effect of silver nitrate or mercuric chloride treatments was to retard and suppress the growth of fungi. The growth curves for these treatments differ from those of the "washer" and hydrogen peroxide, in being flatter and more irregular. Practically all of the fungi growing from "washed" roots, or roots treated with hydrogen peroxide appeared during the first five days of growth, but where silver nitrate and mercuric chloride treatments were used, growth was slow at first and continued so until the ninth day when the last readings were made. A reduction in the time of treatment by these solutions increased the rate of appearance and the number of colonies of fungi.

Isolations from Wheat Kernels

The treatment of kernels presented a somewhat different problem than that of roots, because of the presence of the groove and brush, common locations of seed borne fungi. For isolation purposes, the methods used aimed at destruction or removal of surface matter, leaving internal fungi uninjured. For complete sterilization, as in the preparation of sterile seedings for inoculation studies, the disinfectant which was used had to penetrate quickly and deeply, and it had to be toxic to all forms of external and internal fungi or bacteria, and at the same time not injure the seed.

The results of the wheat seed tests are given in Table 3 and Figures 4 and 5.

It appears from these data that the results desired from plating seeds of wheat will determine the kind of treatment to be used. Abundant and rapid growth of fungi from the seeds was obtained by washing or by soaking in hydrogen peroxide for 20 minutes. Comparative freedom from fungi and good germination were secured by treating the seeds with silver nitrate or with mercuric chloride in water or alcohol. Those are the conditions desired in preparing sterile seedlings. Calcium hypochlorite, as used in these tests did not produce completely sterile seedlings and it reduced the growth of fungi to such an extent that it would not be a very satisfactory treatment for isolation purposes. The hot water and dry heat treatments injured the seeds to so great an extent that it is doubtful whether they would be practicable for the preparation of sterile seedlings. Retardation of growth of fungi from the seeds by silver nitrate and mercuric chloride treatments was just as marked as in the root isolations. Hydrogen peroxide allowed a more regular and vigorous growth than the washer.

Figure 5. A comparison of the numbers of colonies of fungi which grew from wheat roots and seeds after they were treated and plated on agar in petri dishes. Treatments as in Table 3.

A Comparison of Root and Seed Isolations

There was a fair correlation between the results obtained by treating roots and seeds in the same way. The silver nitrate and mercuric chloride treatments permitted a limited growth of fungi from both materials, while the washer and hydrogen peroxide methods of treatment yielded a large number of colonies, particularly from the roots. The number of fungous colonies obtained from the seeds was not as great as that obtained from the roots, where the same treatment was used. A graphical comparison of the results of root and seed isolations is shown in Figure 5.

The Kinds of Fungi Isolated

Fungi with light coloured mycelium, chiefly *Fusaria*, predominated in the root isolations. On the other hand, fungi with dark mycelium were much fewer in number and consisted chiefly of *Helminthosporium sativum*, a few *Alternaria* and some sterile fungi. Colonies of dark coloured fungi were most plentiful in the seed isolations. They consisted mostly of *Alternaria*, a few *H. sativum*, some *Penicillium* and some sterile fungi. The light coloured fungi included a few *Fusaria* or *Fusarium*-like fungi and they occurred in greatest numbers when silver nitrate was used. There seemed to be no relation between the occurrence of light and dark fungi and the kind of treatment used, and practically no correlation existed between the amounts of those two kinds of fungi obtained from roots and seeds treated in the same way. However, light fungi predominated in the platings of both materials when silver nitrate was used as a disinfectant. A yeast-like fungus appeared frequently from both roots and seeds, most of the colonies developing from the seeds. Silver nitrate, mercuric chloride, hydrogen peroxide, calcium hypochlorite and heat prevented their development while the washer treatments, especially where saponin was used, seemed to encourage their growth. The saponin solutions were not the source of the yeasts, as shown by plating drops of the solutions on agar.

Discussion and Conclusions

The methods of treatment which were used in these studies can be classified as (1) washer treatments, (2) chemical treatments, and (3) heat treatments.

The washing apparatus which was used was the same as that described by Simmonds (9). It was found to be convenient when once set up and it permitted rapid handling of large quantities of material. Using sterile water only in the washer gave abundant and rapid growth of fungi from both kinds of material. A little trouble was experienced with *Rhizopus* but not enough to affect the results. Subculturing the contaminated colonies overcame this difficulty. Saponin solutions and alcohol were used in some cases to wet the material previous to washing because these solutions have a lower surface tension than water. The use of alcohol usually resulted in a sacrifice of some fungous growth while the saponin solutions encouraged greater growth of fungi in most cases. The washer method of treatment did not sterilize the material to be plated and therefore it was generally satisfactory for isolation purposes, but unsatisfactory for the preparation of sterile seedlings. This

Figure 6. Potato dextrose agar plates showing growth after 5 days from wheat seeds (left) and roots (right) which had been treated in various ways. The numbers refer to the treatments as indicated in Tables 1 and 3.

method, however, precludes irregularities which may result when poisons are used for treatment purposes.

The chemical treatments which were used are the ones most commonly used for sterilization of plant materials. Silver nitrate gave almost perfect sterilization, and therefore could not be used successfully for isolation of fungi from delicate tissues such as roots or pieces of coleoptile, unless the period of treatment was very short. A twenty-minute period of treatment of the seeds did not injure their germinative capacity greatly and it is likely that longer periods could be used without doing so. The main use of this treatment would appear to be in the preparation of sterile seedlings from diseased seeds.

Mercuric chloride in water or alcohol was somewhat toxic to both external and internal fungi of roots and seeds, as indicated by the relatively small number of fungous colonies which grew from the material that was sterilized in this way. After a ten-minute treatment, too few fungi grew from the roots to make the treatment applicable to such material. A five-minute treatment of roots was better, and gave about the same results as a very short (1½ minute) treatment with alcoholic mercuric chloride. It appears that if mercuric chloride is to be used for sterilizing delicate tissues, the time of treatment and strength of solution must be reduced from those which were used in these studies. As a method for preparing sterile seedlings or even for isolating internal fungi, the mercuric chloride treatment was satisfactory, but it destroyed nearly all of the surface fungi and tended to retard the growth on the plates.

Calcium hypochlorite permitted a good growth of fungi from the roots but a rather poor growth from the seeds. Hence it could be used in isolation work with roots or similar material, if the solution were freshly made for each test. Satisfactory sterilization of seed by this method evidently requires a longer period of treatment than that given in these tests.

Hydrogen peroxide evidently has little toxic effect on fungi, because many colonies developed from the roots and seeds which were treated with it. If the strength of the solution could be maintained it would provide an alternative method to the washer for isolation purposes, but because of its low toxicity it does not seem satisfactory for use in the preparation of sterile seedlings.

The heat treatments of wheat seeds were not satisfactory for either isolation or sterilization purposes, because the seeds were injured seriously and the number of colonies of fungi which developed was reduced to a minimum.

Summary

1. The "washer" method of treatment for isolations from roots and seeds gave consistently good results. Saponin solutions and alcohol were used in conjunction with sterile water in the washer and they facilitated wetting of the material previous to washing.

2. Hydrogen peroxide permitted good growth from roots and seeds but the original strength of the solution was difficult to maintain.

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3. Calcium hypochlorite, when freshly made, was satisfactory for isolation purposes, but the time of treatment (20 minutes) was not long enough to give complete sterilization of the seeds.

4. Mercuric chloride in water or alcohol was not completely satisfactory as a disinfectant for isolation work with roots and seeds but it effected very good sterilization of the seeds and did not injure their germinative capacity seriously.

5. One-hundredth normal silver nitrate solution was found to be of no use for isolation purposes, but it proved very satisfactory for the preparation of sterile seedlings.

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STUDIES OF THE CROWN RUST, *PUCCINIA CORONATA* CORDA[1]

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In Europe extensive studies of the alternate hosts and biologic specialization of the crown rust were made by Klebahn, Eriksson and Muhlethaler. In the United States the most important investigations of these phases of the crown rust have been made by Melhus, Dietz and Willey (*4*) and by Dietz (*1*).

The results of occasional culture work and field study in Western Canada during the years 1922-24 were reported by the senior author (*2*). A more intensive study was made during the years 1925-27. The investigation was confined largely to the hosts occurring in the Prairie Provinces of Canada.

Before the study was in progress long it was recognized that aecia of the crown rust occurred in four species of shrubs in Western Canada.—*Rhamnus cathartica, Rhamnus alnifolia, Lepargyraea canadensis* and *Elaeagnus commutata.* Field study indicated the following relationship of the aecia of crown rust:

Aecial Host	Common Telial Hosts
Rhamnus cathartica	*Avena* species (cultivated)
Rhamnus alnifolia	*Calamagrostis* spp.
Lepargyraea canadensis	*Bromus ciliatus*
Elaeagnus commutata	*Calamagrostis elongata* var.

Aecia were obtained in quantity and in good condition on these four hosts and inoculations were made on a number of grasses in the greenhouse. The leaves bearing the aecia were suspended above the grasses in a moist chamber so that the aeciospores were shed on the grasses below. Uredospores were also used in the inoculations. These were obtained from the aecial inoculations. The most susceptible grass was used to carry each variety of rust in the greenhouse: *Avena sativa* for the variety on *Rhamnus cathartica, Calamagrostis canadensis* for the variety on *R. alnifolia, Bromus ciliatus* for the variety on *Lepargyraea canadensis* and a form of *Calamagrostis elongata* for the variety on *Elaeagnus commutata.*

Inoculations were made with aecial material during the season in 1925, 1926, 1927 and uredospore inoculation was carried on during the fall and spring of each year in the greenhouse; the light was too poor for good growth of the host plants in mid-winter. Generally the inoculations were repeated a number of times. In a few cases when the grasses used in the test were not native or common in the area covered by the investigation only one test was made, unless it was desirable to compare the results with those of United States workers, or if the results of the inoculation were not definite. A summary of the results of the inoculations follows.

[1] Paper read before the Canadian Phytopathological Society, Guelph, Ontario, June, 1931.
[2] Professor of Biology, and Graduate Student respectively.

Table 1.—Variety *Avenae* (*Puccinia coronata Avenae*).

Susceptible Hosts. Heavy Normal Infection.

Achryodes aureum
Avena abyssinica
Avena brevis
Avena fatua
Avena nuda
Avena sativa
Avena sterilis
Avena strigosa

Moderately Susceptible Hosts. Moderate Infection.

Calamagrostis elongata var.
Festuca myuros
Festuca saximontana
Holcus lanatus
Lagurus ovatus
Phleum pratense
Puccinellia tenuiflora
Trisetum flavescens

Slightly Susceptible Hosts. Slight Infection.

Alopecurus aristulatus
Avena barbata
Beckmannia erucaeformis
Bromus pumpellianus
Koeleria gracilis
Phalaris arundinacea

Very Resistant Hosts

Bromus ciliatus
Calamagrostis canadensis
Calamagrostis elongata
Dactylis glomerata
Elymus Macounii
Festuca elatior
Lolium temulentum var. *macrochaeton*
Scolochloa festucacea
Spartina gracilis
Torresia odorata

Immune Hosts. No Infection.

Agropyron cristatum
" *dasystachyum*
" *elongatum*
" *intermedium*
" *inerme*
" *repens*
" *Richardsoni*
" *Smithii*
" *spicatum*
" *tenerum*
Agrostis alba
" *canina*
" *stolonifera*
Alopecurus pratensis
Andropogon furcatus
Anthoxanthum odoratum
Arrhenatherum elatius
Avena flavescens
" *Hookeri*
" *striata*
Bromus ciliatus
" *inermis*
" *latiglumis*
" *Porteri*
" *purgans*
Bromus tectorum
" *uniloides*
" *villosus*
" *patula*
Calamovilfa longifolia
Cynosurus cristatus
Danthonia intermedia
Deschampsia caespitosa
Elymus canadensis
" *curvatus*
" *diversiglumis*
" *glaucus*
" *virginicus*
Festuca duriuscula
" *fenas*
" *ovina*
" *pratensis*
Hordeum jubatum
Hystrix patula
Lolium multiflorum
" *perenne*
" *temulentum*
Muhlenbergia cuspidata
Panicularia grandis
Phalaris canariensis

Poa annua
" *compressa*
" *pratensis*
" *triflora*
" *trivialis*
Schizachyrium scoparium
Spenopholis obtusata
Stipa comata
" *viridula*

From these experiments it appears that the oat variety in Western Canada has telia on cultivated species of *Avena* and *Avena fatua* and that none of the grasses tested, except a southern grass, *Achryodes aureum*, are congenial hosts. Melhus, Dietz and Willey (*4*) found *Anthoxanthum oderatum*, *Alopecurus pratensis* and *Arrhenatherum elatius* very susceptible to the oat variety. In our experiments they were immune.

This variety is usually common on cultivated oats and *Avena fatua* and the aecial stage on *Rhamnus cathartica* especially in the southern part of the area. Some years it is very severe on these hosts and does much injury to the oat crop. Though the rust is so common on cultivated species of *Avena* and *Avena fatua* yet no collections on other grasses that could be assigned to the oat variety have ever been made in the Prairie Provinces. These field observations support the results of the culture experiments and indicate that the native grasses in this area play little or no part as hosts of this rust.

The results of the inoculations on *Calamagrostis canadensis* and *Scolochloa festucacea* were not always uniform, while several inoculations using aecia from *Rhamnus cathartica* and uredospores from cultivated oats gave very slight infection. A collection of uredospores on oats in 1926 gave moderate infection on *Calamagrostis*, and aeciospores from *Rhamnus cathartica* in one trial in 1927 infected rather heavily *Scholochloa festucacea*. The conflicting results may have been due to different biologic forms. A number of tests indicated that physiologic form 3 was the only one present.

Table 2.—Variety *Calamagrostis* (*Puccinia coronata Calamagrostis*).

Very Susceptible Hosts. Heavy Normal Infection.

Calamagrostis canadensis *Calamagrostis elongata*

Somewhat Susceptible Hosts. Moderate Infection.

Beckmannia erucaeformis
Calamagrostis elongata var.
Cinna latifolia
Hystrix patula
Lolium temulentum var. *macrochaeton*
Phlaris arundinacea
Scolochloa festucacea
Torresia odorata

Slightly Susceptible Hosts. Weak Infection.

Avena fatua
" *nuda*
Avena sativa
Festuca myuros

Immune Hosts. No Infection.

Achryodes aureum
Agropyron dasystachyum
" *elongatum*
" *repens*
" *Richardsoni*
" *Smithii*
Bromus hordeacus
" *patula*
Calamovilfa longifolia
Cynosurus cristatus
Dactylis glomerata
Deschampsia caespitosa

Agropyron spicatum
" *tenerum*
Agrostis alba
" *canina*
" *stolonifera*
Alopecurus aristulatus
" *pratensis*
Anthoxanthum odoratum
Arrhenatherum elatius
Avena flavescens
" *Hookeri*
" *striata*
Bromus ciliatus
" *inermis*
" *latiglumis*
" *Porteri*
" *Pumpellianus*
" *purgans*
" *tectorum*
" *uniloides*
" *villosus*
Distichlis spicata
Elymus canadensis
" *curvatus*
" *diversiglumis*
" *innovatus*
" *Macounii*
" *robustus*
" *virginicus*
Festuca arundinacea
" *elatior*
" *ovina*
" *pratensis*
" *saximontana*
Holcus lanatus
Koeleria gracilis
Lagurus ovatus
Lolium perenne
Panicularia grandis
Phleum pratense
Stipa viridula
Triticum compactum

The most striking difference from the results of Melhus, Dietz and Willey is that *Calamovilfa longifolia* proved immune. They found this species was susceptible. No collections of *P. coronata* have ever been made on this host though it is very common in the Prairie region of Canada.

Crown rust is abundant on species of Calamagrostis in the northern part of Western Canada. *Rhamnus alnifolia* is often associated with these grasses and usually is severely attacked by the aecial stage. Some seasons crown rust is very prevalent on *Scolochloa festucacea*, a very abundant grass in the prairie sloughs. This rust seems to belong to the variety *Calamagrostis* though conflicting results were obtained by inoculation. Some collections of aecia in *Rhamnus alnifolia* gave heavy normal infection on *Scolochloa;* others gave only weak infection. This probably can be explained by the presence of biologic forms of this variety. Collections of crown rust were made on *Cinna latifolia* in Northern Saskatchewan which from association with aecia on *Rhamnus alnifolia* evidently belonged to this variety.

TABLE 3.—Variety *Bromi* (*Puccinia coronata Bromi*).

This variety is common in northern parts of Saskatchewan where both *Bromus ciliatus* and *Lepargyraea canadensis* occur together. It is for convenience designated in this paper as variety *Bromi.*

Very Susceptible Hosts. Heavy Infection.

Bromus ciliatus — *Bromus Pumpellianus*
" *latiglumis*

Somewhat Susceptible Hosts. Moderate Infection.

Beckmannia erucaeformis — *Puccinellia tenuiflora*
Bromus Porteri — *Lolium temulentum*

Bromus patulus
Hystrix patula
Lolium temulentum var. *macrochaeton*

Slightly Susceptible Hosts. Weak Infection.

Agropyron cristatum
" *spicatum*
" *Richardsoni*
" *tenerum*
Bromus purgans
" *tectorum*
" *villosus*
Calamagrostis elongata var.
Elymus robustus
Panicularia grandis
Phalaris arundinacea
Phleum pratense
Spartina gracilis
Stipa viridula
Torresia odorata

Very Resistent Hosts. Trace of Infection.

Agropyron dasystachyum
Elymus diversiglumis
Lolium multiflorum
Scolochloa festucacea

Immune Hosts. No Infection.

Achryodes aureum
Agropyron elongatum
" *repens*
" *Smithii*
Agrostis alba
" *canina*
" *stolonifera*
Alopecurus aristulatus
Bromus inermis
" *uniloides*
Calamagrostis canadensis
" *elongata*
Cinna latifolia
Chaetochloa glauca
Cynosurus cristatus
Dactylis glomerata
Deschampsia caespitosa
Distichlis spicata
Elymus canadensis
" *curvatus*
" *innovatus*
" *glaucus*
" *Macounii*
" *virginicus*
Festuca arundinacea
" *duriuscola*
" *elatior*
" *fenas*
" *myuros*
" *ovina*
Alopecurus pratensis
Anthoxanthum odoratum
Avena fatua
" *flavescens*
" *Hookeri*
" *sativa*
" *sterilis*
" *striata*
Festuca pratensis
Holcus lanatus
Hordeum jubatum
Koeleria gracilis
Lagurus ovatus
Lolium perenne
Muhlenbergia cuspidata
" *racemosa*
Phalaris canariensis
Phragmitis Phragmitis
Poa annua
" *compressa*
" *pratensis*
" *triflora*
" *trivialis*
Spenopholis obtusata
Stipa comata
Trisetum flavescens
Triticum compactum
" *vulgare*
" *durum*

Collections of crown rust were made on *Agropyron tenerum*, *Bromus ciliatus* and *Elymus innovatus* that from field evidence of association with aecia on *L. canadensis* could be definitely assigned to this variety.

Innoculations were made from aeciospores collected on *Lepargyraea canadensis* at Banff, Alberta, and moderate infection obtained on *Bromus Pumpellianus* and slight infection on *Agropyron spicatum*, *A. tenerum* and *E. canadensis* but no further inoculations were made. The *Agropyron* species and *Elymus canadensis* were more susceptible than to the aecial collections made on the prairie.

Variations in the degree of infection were noted in the grasses *Bromus Porteri*, *Bromus purgans*, *Calamagrostis elongata* var., *Festuca saximontana*, *Hystrix patula* and *Lolium multiflorum*. This was probably due to biologic forms of this variety.

Dietz (*1*) inoculated *Lepargyraea canadensis* with teliospores from *Calamagrostis purpurascens* and obtained heavy normal infection. He also reports the inoculation of *Avena sativa* with aeciospores from *L. canadensis* and the development of uredospores but does not consider the results conclusive as the aecia were not produced under controlled conditions.

Variety *Elaeagni* (*Puccinia coronata Elaeagni*).

Many inoculations were made with aeciospores from *Elaeagnus commutata* on a number of grasses. Infection was always obtained on a species of *Calamagrostis* and on no other grass. This species or variety was close to *Calamagrostis elongata*, but differed markedly in its habitat, habit of growth and leaf characters. It preferred dry, sandy soil, only maturing fruit under these conditions; the leaves are firm and bluish green, resembling somewhat those of *Agropyron Smithii*. It was determined by Dr. Malte as a dry ground form of *Calamagrostis elongata*. It could readily be distinguished in the field from typical *C. elongata* by the characters mentioned above and in every inoculation with aeciospores from *Elaeagnus commutata* was heavily infected. Typical *Calamagrostis elongata* was immune. To distinguish this grass from *Calamagrostis elongata* it is designated in this paper as *Calamagrostis elongata* var. In the previous paper (*2*) it was designated as *Calamagrostis inexpansa*. There never was a trace of infection on any other grass, not even flecking except on *Achryodes aureum* which was slightly susceptible.

This variety of *Puccinia coronata* is designated for convenience in this paper as *Elaeagni*.

Table 4.—Variety *Elaeagni* (*Puccinia coronata Elaeagni*).

Very Susceptible Hosts. Heavy Infection.

Calamagrostis elongata var.

Slightly Susceptible Hosts. Weak Infection.

Achryodes aureum.

Immune Hosts. No Infection.

Agropyron cristatum	*Deschampsia caespitosa*
" *dasystachyum*	*Elymus canadensis*
" *Richardsoni*	" *curvatus*

Agropyron Smithii
" *spicatum*
" *tenerum*
Alopecurus aristulatus
Avena Hookeri
" *sativa*
" *sterilis*
" *striata*
Beckmannia erucaeformis
Bromus ciliatus
" *latiglumis*
" *Porteri*
" *Pumpellianus*
" *patulus*
Calamovilfa longifolia
Calamagrostis canadensis
" *elongata*
Scolochloa festucacea
Spartina gracilis
Spenopholis obtusata
Sporobolus heterolepis
Stipa viridula
Elymus diversiglumis
" *innovatus*
Festuca arundinacea
" *elatior*
" *ovina*
" *pratensis*
" *saximontana*
Hordeum jubatum
Koeleria gracilis
Lagurus ovatus
Lolium perenne
" *temulentum*
var. *macrochaeton*
Panicularia grandis
Phalaris arundinacea
Poa pratensis
" *trivialis*
Torresia odorata
Trisetum flavescens
Triticum compactum
" *vulgare*

Inoculations with germinating teliospores obtained from the most congenial grass hosts of the varieties were made in the four aecial hosts. The results are summarized in Table 5.

TABLE 5.—*Inoculations with basidiospores.*

Telial Host	Rhamnus cathartica	Rhamnus alnifolia	Lepargyraea canadensis	Elaeagnus commutata
Avena sativa	Heavy infection	Pycnia, rarely aecia	No infection	No infection
Calamagrostis canadensis	No infection	Heavy infection	No infection	No infection
Scolochloa festucacea	No infection	Moderate infection	No infection	No infection
Bromus ciliatus	No infection	No infection	Heavy infection (pycnia rare)	No infection
Calamagrostis elongata var.	No infection	No infection	No infection	Heavy infection (no pycnia)

Difficulty was found in obtaining the germination of the teliospores of *Puccinia coronata* on *Avena sativa*. The teliospores were treated with various chemical solutions and exposed to various conditions without success. This difficulty was overcome by a method devised by the junior author in the spring of 1928. Overwintered teliospores sprayed for several days with a fine spray of water delivered with considerable force germinated freely. The spray was obtained by attaching a fine nozzle to a water tap.

Inoculations were also made with germinating teliospores of all the varieties on *Elaeagnus angustifolia* and *Lepargyraea argentea* without infection. As aecia of the crown rust were never collected on these shrubs it is further evidence that they are not congenial hosts. The aecia of *Puccinia Caricis-Shepherdiae* (*3*) are abundant on the prairies on *Elaeagnus commutata, Elaeagnus angustifolia, Lepargyraea canadensis* and *Lepargyraea argentea.* These aecia can easily be separated from those of *Puccinia coronata* as they occupy a large area of the leaf, prominent pycnia are present, usually showing a radiating arrangement from a common centre and the peridium is usually not reflexed. In *P. coronata* the aecia are in small groups, pycnia are not usually formed, the peridium is more reflexed and the aecia when fresh are a deeper orange in color.

Inoculations with the germinating telia of *P. coronata Avenae* on *Avena sativa* were made on *Rhamnus frangula.* Pycnia developed sparingly on one shrub but aecia did not follow.

Collections of crown rust were made in several localities on *Deschampsia caespitosa.* This grass was immune to all the aecial material of *P. coronata* collected though it was repeatedly inoculated. There was no evidence to indicate to which variety it belonged.

A morphological study was made of the four varieties indicated by the culture experiments. Material for sectioning was obtained from the plants infected in the greenhouse and from field collections. This material was fixed in chrom-acetic fixer and stained in Haidenhain's iron-alum haematoxylon, Fleming's triple stain, or safranin and light green.

No pycnia were present in the variety *Elaeagni* on *Elaeagnus commutata.* They were rarely present in field collections of the variety *Bromi* on *L. canadensis.* In the greenhouse cultures of the latter variety, pycnia were obtained for sectioning. The pycnia did not present a normal appearance. The mycelium was not massed together so closely and the pycniospores were not so abundantly produced as in the varieties on Rhamnus. The pycnia averaged in diameter 108 μ which is slightly larger than in the variety *Calamagrostis* and smaller than the variety *Avenae.*

In the varieties on *Rhamnus* pycnia were formed abundantly in the cultures about five days after inoculation. They were arranged in irregular clusters. Nectar was abundant. In variety *Avenae* they averaged 124 μ in diameter and in variety *Calamagrotis* 100 μ. Pycnia were usually formed in the upper side of the leaf, but occurred also on the lower side.

The aecia appear about ten days after inoculation on the lower side of the leaf. They are produced on the blade of the leaf in varieties *Elaeagni* and *Bromi* without any marked hypertrophy of the tissues. In the varieties *Avenae* and *Calamagrostis* they occurred on the blade, midrib, young shoots and fruits usually with marked hypertrophy. The arrangement of the aecial cups is usually characteristic. In the varieties *Elaeagni* and *Bromi* they are arranged in small circular groups. There is a marked chlorotic area around the aecia in *Bromi.* This is not present in variety *Elaeagni.* This difference may be due to the silvery appearance of the leaves of *Elaeagnus.* The aecia are lighter in color in variety *Elaeagni* than in the others and the color fades more rapidly.

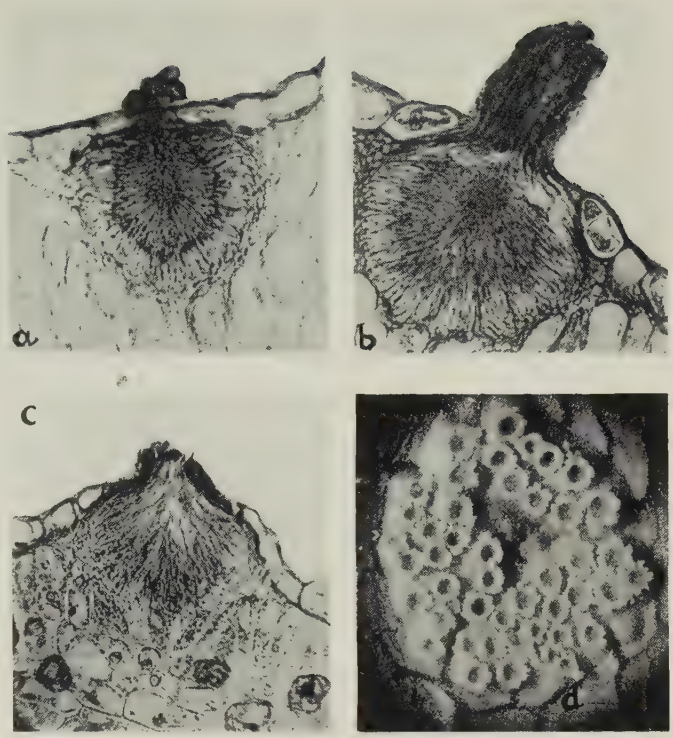

Figure 1. (a) Section of pycnium of *P. coronata Calamagrostis* on *Rhamnus alnifolia* (x420). (b) Section of pycnium of *P. coronata Avenae* on *Rhamnus cathartica* (x420). (c) Section of pycnium of *P. coronata Bromi* on *Lepargyraea canadensis* (x420). (d) Aecia of *P. coronata Avenae* on *Rhamnus cathartica*.

Figure 2. (a) Teliospores of *P. coronata Elaeagni* from *Calamagrostis elongata* (x450). (b) Teliospores of *P. coronata Avenae* from *Avena sativa* (x450). (c) and (d) Teliospores of *P. coronata Bromi* from *Bromus* (x450).

Measurements of the diameter of the aecial cups were made from the sections. These were found to vary with the conditions under which they were developed and from year to year. Field collections of the variety *Bromi* on *L. canadensis* in 1928 averaged 276 μ in diameter, and aecia collected in 1927 averaged 216 μ. Those developed in the greenhouse showed a smaller diameter.

A summary of the measurements of 50 cups in each form is given in Table 6.

TABLE 6.—*Summary of measurements of 50 aecial cups.*

Biologic form	Average measurement in microns			Number of basal cells in aecial cup	Thickness of peridium
	Diameter of pycnia	External diameter of aecial cup	Internal diameter of aecial cup		
Puccinia coronata Bromi	108.99	215.85	180.88	23.4	12.05
Puccinia coronata Calamagrostis	103.3	175	123.68	19.2	12.58
Puccinia coronata Avenae	124.44	263.52	162.07	24.2	11.68
Puccinia coronata Elaeagni	....	242.41	158.7	20.4	11.07

The urediniospores of all the four varieties do not differ in color or the character of the echinulations. There are 4-6 scattered pores which were easily seen on germination, or by treating with lactic acid.

The aeciospores show less variation in size than the other spore forms. Aeciospores of *P. coronata Avenae* kept in a refrigerator remained viable for 180 days.

The teliospores of the varieties showed more variation in size and shape as will be seen from Figure 2 and are more affected by the characteristics of the hosts.

Five hundred measurements for both length and width of urediniospores were made for each variety of the rust studied and two hundred and fifty of each for aeciospores and teliospores. The urediniospores and aeciospores were measured through their greatest diameter as length and at right angles to this for width. In the teliospores longitudinal measurement was taken from the exterior of the apex to the point of attachment of the pedicel. The transverse measurements were made across the crown of the spore just above the upper cell. All measurements of urediniospores and aeciospores were made on dried material mounted in 25% solution of acetic acid and water. The teliospores were measured in a water mount.

A comparison of the mean lengths and widths of the spores of the four varieties studied is shown in Tables 7 and 8.

TABLE 7.—*Mean lengths of spore types of varieties of Puccinia coronata.*

Variety	Urediniospore	Aeciospore	Teliospore
P. coronata Bromi	20.484±.0520	20.832±.0686	41.588±.1806
P. coronata Calamagrostis	20.314±.0536	20.620±.0615	49.736±.3295
P. coronata Avenae	24.080±.0553	22.700±.0684	60.540±.3200
P. coronata Elaeagni	23.999±.0618	21.708±.0582	63.408±.4030

TABLE 8.—*Mean width of spore types of varieties of Puccinia coronata.*

Variety	Urediniospore	Aeciospore	Teliospore
P. coronata Bromi	17.72±.0363	18.476±.0598	15.344±.0702
P. coronata Calamagrostis	17.486±.0363	18.432±.0467	16.656±.0721
P. coronata Avenae	20.364±.0394	19.416±.0520	17.044±.0896
P. coronata Elaeagni	20.090±.0409	19.172±.0480	15.416±.0754

A statistical study was made of the size of the aeciospores and urediniospores and teliospores of the four varieties and curves plotted. This study indicated a close relationship between the varieties *Calamagrostis* and *Bromi* and also between *Avenae* and *Elaeagni*. If spore size alone were considered it would indicate that there were two groups, one composed of varieties *Avenae* and *Elaeagni* and a second composed of varieties *Calamagrostis* and *Bromi*.

The relationship of the aecial hosts and the characters of the aecia seem to be of greater value in determining relationship than spore size. Some of the aecial characters indicate that there are two groups, one consisting of varieties *Avenae* and *Calamagrostis*, both with pycnia and aecia on *Rhamnus* species, pycnia always developing and aecia usually forming an irregular cluster on the leaf with hypertrophy; the second consisting of the varieties *Bromi* and *Elaeagni* with aecia on the *Elaeagnaceae*, pycnia not or rarely developed, the aecia in small circular groups.

SUMMARY

Culture experiments and characters of aecia indicate four varieties of *Puccinia coronata* in the prairie provinces of Canada:

Puccinia coronata Avenae with aecia on *Rhamnus cathartica* and uredinia and telia on cultivated species of *Avena* and *Avena fatua;*

Puccinia coronata Calamagrostis with aecia on *Rhamnus alnifolia* and uredinia and telia chiefly on species of *Calamagrostis* and *Scolochloa festucacea;*

Puccinia coronata Bromi with aecia on *Lepargyraea canadensis* and uredinia and telia chiefly on *Bromus ciliatus, B. latiglumis, B. Porteri;*

Puccinia coronata Elaeagni with aecia on *Elaeagnus* and uredinia and telia on a form or variety of *Calamagrostis elongata.*

The relationship of the aecial hosts and some of the morphological characters of the aecia suggest that the varieties on *Lepargyraea canadensis* and *Elaeagnus commutata* respectively are distinct from *Puccinia coronata* on *Rhamnus* species. A statistical study of the size of the aeciospores, urediniospores and teliospores does not support this view.

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CURRENT PUBLICATIONS

FARM MANAGEMENT IN SOUTH AFRICA. E. Sewell Dawson. South African Agricultural Series, Volume 9. Published by the Central News Agency, Johannesburg. Price 22/6d.

In his preface the author states that "In South Africa farming is passing through a transitional period, relative values are changing, much of the soil is becoming washed out, and it has become urgently necessary that methods be improved. This book has been written in the hope that it will afford enlightenment on the problems of organization and management confronting farmers, particularly novices, and that it will give an impetus to the improvement of farming methods".

The author, who is Farm Manager of the Experiment Farm at Pretoria University, points out that studies and publications on farm management are not available to farmers of different localities in South Africa as they are in the older countries where farming is more stereotyped. Hence he has given much detail which does not generally appear in book form in the United States and Canada, but which we have in bulletin and circular form.

The book should prove of great value to those who are capable of using it. It is well written, the points clearly stated and the style interesting enough to hold a farmer's attention. For students of agricultural economics in other countries it presents a good picture of South African farm problems. In addition to the fifteen chapters on special aspects of farm management there is a chapter on Marketing and Co-operation and a chapter on Records and Accounts. Charts are given showing the fluctuation in market prices over a five year period of the following products: maize, teff hay, monkey nuts, potatoes and prime beef. Another chart gives the price of baconers from 1917 to 1930, showing a four to five year price cycle with peaks at 1920, 1924 and 1929. —H.L.T.

A STUDY OF BUTTERFAT VARIATIONS IN COWS' MILK

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Introduction

Milk producers and dairy scientists alike are deeply interested in the fluctuations that normally occur in the fat test of cows' milk. These fluctuations are of two general types: the day-to-day variations which may be ascribed chiefly to the factors of individuality and environment, and the long-time trends which are influenced by season, age, stage of lactation, etc. Herd records furnish the data required for a study of the latter factors, and, because of the availability of such material, the influence of these factors has been measured with considerable accuracy. Attempts to explain the daily variations in a rational manner have not been so successful because of the experimental difficulties encountered. Individuality is a factor of great importance and one which must be eliminated in any study of the influence of environmental factors upon the butterfat percentage before the specific influence of the factor studied can be accurately estimated. The problem of butterfat test variations is a large and complicated one and its solution will involve an enormous amount of experimental work. This work will have to include a detailed study of the physiology of the mammary system as well as the specific effect of the various environmental factors concerned.

The Extent to Which Milk Varies in Fat Content

Until recently, textbooks on dairying seem to have minimized the extent of the variations in fat test that may be found under practical conditions; consequently, these variations are greater than is popularly supposed. The extent of the variations that may be found is well illustrated by the work of Anderson (*1*) who studied 2,000 seven-day official records in Michigan. These results showed that 28.45% of the 2,000 cows produced milk that showed a *variation* of 0.0% to 1.0% in the seven-day period; 54.55% varied from 1.1% to 2.0%; 13.4% varied from 2.1% to 3.0%; 2.65% varied from 3.1% to 4.0%; 0.8% varied from 4.1% to 5.0%; and 0.15% (three cows out of the 2,000) showed variations as great as 5.1% to 6.0%. It is interesting to note that the largest single group of these cows showed a variation of 1.1% to 2.0%, and that extreme variations may be found occasionally. Cranfield (*3*) has reported that, with a herd of 30 to 35 cows, the day-to-day variation in herd milk may easily extend to 1.0% of fat. The variation in solids not fat was less than the variation in fat and the evening's milk was more variable than the morning's milk.

A study of the daily average test of the mixed milk of five cows in our herd during the period, October 19th, 1930 to November 18th, 1930 inclusive shows that the maximum variation for the month was 1.03%, while day-to-day variations of over 0.5% occurred four times during this period.

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TABLE 1.—*Milk yield, percentage of fat, and percentage of solids not fat for seven days, October 1 to 8, 1930*

		October 1			October 2			October 3			October 4			October 5			October 6			Ocrober 7		
Cow	Milking	Lbs. Milk	% Fat	% SNF	Lbs. Milk	% Fat	% SNF	Lbs. Milk	% Fat	% SNF	Lbs. Milk	% Fat	% SNF	Lbs. Milk	% Fat	% SNF	Lbs. Milk	% Fat	% SNF	Lbs. Milk	% Fat	% SNF
A114	A.M.	12.3	4.0	9.10	11.4	3.2	9.00	11.7	4.0	9.07	12.4	3.7	9.05	13.5	3.6	9.00	12.8	3.4	8.95	12.0	3.4	8.90
A114	P.M.	8.1	4.2	9.30	9.0	4.0	9.00	9.1	3.8	9.35	9.0	4.0	9.15	12.8	4.0	9.15	9.1	4.0	8.97	9.0	3.9	9.17
A127	A.M.	13.5	4.2	9.25	12.0	3.0	9.15	12.7	3.6	9.32	14.0	3.5	9.10	12.5	2.8	9.20	11.2	3.2	9.15	11.5	3.7	9.17
A127	P.M.	13.0	4.2	9.55	14.0	3.4	8.60	13.3	4.4	9.62	11.5	4.4	9.25	13.7	4.7	9.20	14.0	4.8	9.30	13.0	4.8	9.32
H142	A.M.	17.1	3.0	7.67	16.0	1.7	7.50	16.9	3.0	7.60	17.1	2.3	7.60	19.0	2.3	7.95	19.1	3.7	7.87	16.5	2.8	7.67
H142	P.M.	16.5	2.6	7.90	18.0	3.6	7.90	19.0	3.9	7.87	17.4	3.0	7.65	17.4	4.3	7.97	16.2	3.4	7.70	15.4	1.8	7.70
H146	A.M.	13.7	3.5	7.85	13.7	2.4	8.27	14.1	4.1	8.17	16.8	3.6	8.42	12.2	2.0	8.02	13.6	4.0	8.17	13.5	3.8	8.25
H146	P.M.	12.1	2.7	8.17	10.8	3.6	8.40	10.8	3.0	8.40	10.8	3.9	9.00	14.6	4.3	9.22	14.0	3.4	8.35	16.0	4.8	9.15
H179	A.M.	15.7	3.5	9.05	14.0	3.2	8.97	14.7	3.9	9.00	15.7	3.4	9.10	13.8	2.8	8.92	14.0	3.6	8.95	11.5	2.4	9.02
H179	P.M.	11.0	4.2	9.55	14.0	4.4	9.35	12.5	4.3	9.60	12.5	2.7	8.20	13.2	4.6	8.30	13.5	4.4	9.07	8.8	2.6	8.27

Most of the studies on the variability of milk have dealt with fluctuations in the fat test. The amount of other constituents present may vary also, but the fat variations are usually of more importance from the commercial standpoint and these are also more prominent because milk is tested for butterfat so extensively. Total milk solids and milk solids not fat are frequently found to vary in the same directions as the fat test, but the extent of the variations is usually much less. This is illustrated in Tables 1 and 4, in which the analysis of the milk of five cows for a period of seven days is presented. In this case, the solids not fat was calculated from the lactometer reading and the fat test by the formula of Babcock.

Factors Responsible for the Long Time Trend in Fat Variations

Influence of age of cow.

It is held by some that age of cow has an effect upon the average butterfat test. A number of workers have noted a decline in fat test during the later years of life, although there is some lack of agreement about the age at which the decline begins. According to a Scottish survey in which 861 cows were considered, the highest fat test of 3.89% was for two-and-one-half-year-old cows, and the age levels were graduated down to the low level of 3.56% for ten-year-old cows.

A study of 218 lactations in the herd of the University of Saskatchewan between 1918 and 1929 showed average fat tests as follows: for two-year-olds, 3.74%; for six-year-olds, 3.66%; and for ten-year-olds, 3.61%. Insufficient numbers were available for conclusive evidence, but the figures presented indicate that age influences fat test only a little. These data are in agreement with the idea that there is a slight decline in fat with advancing age.

Table 2.—*Fat percentages by months.*

Month	Average for 121 Lactations % Fat Holstein-Friesian	Average for 123 Lactations % Fat Ayrshire	Average for 244 Lactations % Fat Both Breeds
January	3.431	4.195	3.816
February	3.539	4.163	3.854
March	3.470	4.203	3.839
April	3.432	4.024	3.731
May	3.424	4.012	3.720
June	3.258	3.913	3.588
July	3.218	3.094	3.564
August	3.226	4.045	3.638
September	3.298	4.066	3.685
October	3.416	4.045	3.733
November	3.358	4.087	3.725
December	3.372	4.178	3.778

Seasonal variation in fat tests.

It is noticeable that herd tests are usually higher in the winter months than in the spring and summer. An analysis of the herd records at the University of Saskatchewan for the twelve-year period, 1918 to 1929 inclusive, indicates that the high point is struck in the late winter months and the low point in the early summer. In this study, the lactations of 121 purebred Hol-

steins and 123 purebred Ayrshires were considered, and the freshenings were distributed as evenly over the entire year as possible in order to eliminate the influence of stage of lactation. Our present knowledge of milk secretion is not sufficiently complete to permit an explanation of this seasonal change, but such factors as succulence of feed, exercise, yield of milk, condition of the bowels, and temperature may have parts to play.

The average fat tests for the months of the year were found as in Table 2.

The average monthly fat tests, computed from 244 lactations, are also presented graphically in Figure 1. These show what may be a normal seasonal trend in butterfat percentage.

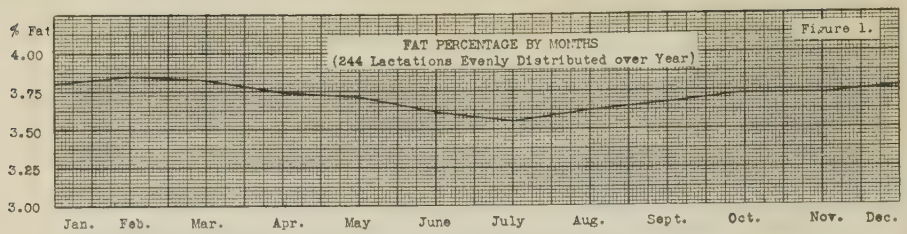
THE INFLUENCE OF STAGE OF LACTATION UPON FAT TESTS.

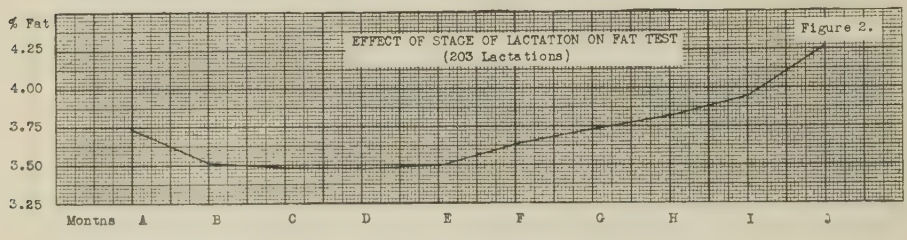
An analysis was made of a large number of lactations of cows in the herd of the University of Saskatchewan for the twelve-year period, 1918 to 1929 inclusive. Lactations commenced in approximately equal numbers of times in each month of the year, thus eliminating the effect of seasonal trends in the butter-fat level. The lactations studied were mostly of ten-months duration, although there were some shorter and some longer periods. The average percentages of butterfat in the milk are shown for ten months in Table 3. Cows that milked for eight months only were entered for the first four and last four months of the ten-month period. Similarly with cows that milked more than ten months, the first five and last five months only were recorded on the ten-month chart. Therefore columns A to D and G to J in Table 3 represent the average tests for the entire number of lactations studied, and columns E and F give the tests for a slightly smaller number of lactations.

TABLE 3.—*Effect of stage of lactation on percentage of fat.*

No. of Month	Average 105 Lactations % Fat Holsteins	Average 100 Lactations % Fat Ayrshires	Average 205 Lactations % Fat Two Breeds
A	3.529	3.957	3.738
B	3.290	3.816	3.534
C	3.194	3.780	3.480
D	3.014	3.837	3.476
E	3.194	3.875	3.512
F	3.252	4.120	3.658
G	3.329	4.154	3.731
H	3.484	4.180	3.824
I	3.612	4.287	3.941
J	4.014	4.542	4.271

Figure 2 was prepared from the averages in the last column of this table. The fat tests were made from composite samples of milk taken from the morning and night milkings on the 10th, 20th, and 30th days of each month. While it is admitted that this system of taking test samples is not always conducive to accurate work, it seems fairly satisfactory for herd and long-time analysis.





The Percentage of Fat in Different Portions of a Single Milking

COMPARISON OF FIRST AND LAST DRAWN MILK.

The first and last drawn portions of a single milking represent widely removed extremes in butterfat percentage. The first drawn milk is frequently as low as 1.0% fat, while the strippings of the same milking may often be as high as 10.0% fat. The average fat content for each of several portions of the milk of five cows for one day (Sept. 20, 1930) follow:

First Streams	First Quart	Second Quart	Third Quart	Fourth Quart	Strippings	Composite
1.1%	1.4%	2.0%	3.1%	4.0%	7.6%	3.26%

In taking samples, the first stream was discarded from each teat and then two-ounce samples taken to represent the first streams. The same size of of sample was taken to represent the strippings. Samples were gathered so that all four quarters of the udder contributed equally to each portion tested.

Of the milk solids, fat alone is widely variable according to portion of the milking. The solids not fat remain relatively constant and show no consistent change between the first streams drawn and the strippings. Table 4 indicates the result of a one-day test with four cows and shows the fat and solids not fat levels for the different portions in both morning and evening milk.

Work done at the Iowa Station (*11*) showed that the creaming process is partially responsible for differences in the fat content of the foremilk and the strippings. Exercising the cows and massaging the udder before milking cause a slight increase in fat test of the first milk drawn and a corresponding decrease in the portion immediately following. The last milk and strippings were not affected.

VARIATION IN MILK FROM QUARTERS OF ONE UDDER.

A substantial fat variation may occur between the milk of different quarters of the same udder. It does not hold that the quarter displaying the

TABLE 4.—*Variation in percentage of fat and percentage of solids not fat of different portions of single milkings.*

Cow	1st Stream		Strippings		Composite	
	% Fat	% S.N.F.	% Fat	% S.N.F.	% Fat	% S.N.F.
Ayrshire						
114 A.M.	1.5	8.87	6.1	8.52	3.2	9.10
114 P.M.	2.0	9.00	5.6	9.15	4.0	9.30
Ayrshire						
127 A.M.	1.7	9.17	6.1	8.77	3.0	9.25
127 P.M.	2.8	9.45	7.8	9.20	4.2	9.55
Holstein						
142 A.M.	1.2	7.30	5.9	7.47	1.7	7.67
142 P.M.	0.9	7.47	6.4	7.35	2.6	7.90
Holstein						
146 A.M.	1.5	7.87	5.1	8.02	2.4	7.85
146 P.M.	1.7	7.92	4.4	8.10	2.7	8.17
Holstein						
179 A.M.	1.3	9.07	5.8	8.70	3.2	9.05
179 P.M.	1.2	9.55	7.0	9.00	4.2	9.55
Average	1.58	8.58	6.02	8.42	3.14	8.73

highest fat test at a given time will always be the highest. As reference to Table 5 will indicate, the low-testing quarter in the morning may be one of the highest at night. This illustrates the difficulties which confront the investigators who endeavor to discover the causes of variation. The cause of variation between two quarters of the udder is certainly not consistent with any environmental condition. It may be due to physiological factors as yet unknown, otherwise the relative test between all four quarters would

TABLE 5.—*Variation in percentage of fat from different quarters.*

Cow	Front Right Quarter % Fat	Front Left Quarter % Fat	Back Right Quarter % Fat	Back Left Quarter % Fat	Composite % Fat
Ayrshire					
127 A.M.	2.9	2.9	1.8	1.8	2.35
127 P.M.	4.1	3.4	3.1	2.7	3.30
Ayrshire					
114 A.M.	2.8	2.5	2.5	2.4	2.55
114 P.M.	3.6	2.7	3.4	2.9	3.15
Holstein					
146 A.M.	4.0	4.0	4.0	3.8	3.95
146 P.M.	4.1	4.2	4.3	4.2	4.20
Holstein					
179 A.M.	3.2	2.6	2.8	2.9	2.87
179 P.M.	4.1	4.0	3.3	3.3	3.67
Holstein					
142 A.M.	.9	1.8	2.0	2.3	1.80
142 P.M.	1.7	2.0	1.7	2.5	1.90

be maintained. It would suggest that the control of daily and individual variations within a herd is impossible, at least with our present knowledge, and the most that we can hope for is to control the consistent trends that are more probably allied with environment. Table 5 is intended to illustrate the extent of the variation that may occur when the various quarters are considered separately.

Some Other Possible Factors Involved in the Day-to-Day Variations

VARIATION IN NIGHT AND MORNING MILK

In what way does the length of interval between milkings influence yield of milk, butterfat percentage and butterfat yield? The asumption is that a long interval between milkings makes for a higher yield of milk, and a lower test of fat. On many farms, the night interval between milkings is longer than the day interval. Whatever may be the effect of length of interval between milkings upon fat test, there appears to be a force not related to this factor that makes the evening milk richer in fat than the morning milk. Warrington (*17*) states that, of the milk coming to London, the evenings' milk is 0.36% richer in fat than the morning's milk. Gowen (*8*) found that the morning milk was from 0.68 to 0.72% lower in butterfat than the evening milk, when the night interval was thirteen hours.

In the 1930 study, it was discovered that, when the twenty-four hour day was divided in an average and practical way allowing eleven hours for the day interval and thirteen for the night interval, the evening milk was richer than the morning milk by 0.44%. This figure was obtained by following five cows from near the beginning to the end of their lactations. There were 1145 morning tests and 1145 evening tests made. The cows studied showed very decided individual differences. The Holstein cow 146 differed from all other cows studied in that she quite consistently showed a higher fat test from the morning milk. Holstein 142 showed only a slight average difference between night and morning milk, while the Holstein cow 179, on the other hand, showed an average difference of .69% in favor of the evening milk. The average tests for these cows are shown in Table 6.

Table 6.—*Percentage of fat in morning and evening milk.*

	Morning Tests Cows milked at 5.30 A.M.		Evening Tests Cows milked at 4.30 P.M.	
	No. of tests made during lactation	Average % Fat	No. of tests made during lactation	Average % Fat
Ayrshire No. 114	267	3.714	268	4.185
Ayrshire No. 127	266	3.668	267	4.394
Holstein No. 142	264	2.685	265	2.846
Holstein No. 146	128	3.545	127	3.525
Holstein No. 179	220	3.644	218	4.342
Five cows	1145	3.435	1145	3.880

The averages of 2566 samples of morning milk and a similar number of samples of evening milk obtained systematically from the cows studied during the past three years show the evening milk to be .66% richer in fat than the morning milk. The morning milk in the herd averaged 3.38% and the evening milk 4.04%. The difference is considerably greater than that reported by British authorities, but consistent with some American observations.

A further trial beginning August 20, 1931, was conducted with six cows for a 75-day period. All cows were milked twice daily. Three cows, described as A 141, A 121 and S 130 were milked at exactly equal intervals of 12 hours while the remaining three cows, A 117, A 145, and S 131 were milked at the usual hours for milking, namely, 5:30 A.M. and 4:30 P.M. All milkings were weighed and samples taken for testing. All cows continued to show the typical higher fat test from the evening milkings, although there was a smaller night and morning difference among the cows milked after equal intervals. The milk yield was higher in the morning for all cows.

The cows being milked at irregular intervals showed a larger test difference between night and morning milkings; but, in actual fat yield, the difference between night and morning milkings was less significant in both groups. This is shown in Table 7.

Sixteen cows milked at 5.30 A.M. and 4.30 P.M. for a 56-day period uniformly showed a higher average butterfat test in the evening than in the morning. The milk yield was 26.05% higher in the morning; but, in actual butterfat yield over the entire period, eight cows showed the largest amount

TABLE 7.—*Percentage of fat and yield of fat from milkings after equal and unequal intervals.*

75-Day Period	Equal Interval			Unequal Interval		
	A 141	A 121	S 130	A 117	A 145	S 131
Av. morning milk yield	17.64 lbs.	11.10 lbs.	5.80 lbs.	21.38 lbs.	12.16 lbs.	7.75 lbs.
Av. evening milk yield	14.05	9.78	5.32	17.83	9.68	6.14
Difference in favor of morning milking	3.59	1.32	0.48	3.55	2.48	1.61
Ave. morning fat test %	3.39%	3.79%	4.03%	3.45%	3.36%	3.88%
Ave. evening fat test %	3.95	4.10	4.31	3.94	4.34	4.47
Difference in favor of evening milking	0.56	0.31	0.28	0.49	0.98	0.59
Average morning yield of fat	0.552 lbs.	0.42 lbs.	0.233 lbs.	0.774 lbs.	0.406 lbs.	0.300 lbs.
Average evening yield of fat	0.551	0.40	0.233	0.705	0.418	0.274
Difference in favor of morning milking	0.001	0.02	0.000	0.069	–0.012	0.026

from the morning milk and the remaining eight showed the largest amount from the evening. This would indicate that, while the level or percentage of fat fluctuates widely from morning to night, the quantitative secretion of fat during day and night is perhaps more stable than we have heretofore supposed.

The common experience is that more milk is secured at the morning milking and that the higher level of butterfat is secured from the evening's milk. Whether due to darkness, inactivity or some other factor, it is quite apparent that milk secretion is accelerated during the night. Woodward (*18*) of the U. S. D. A. found that exercising dairy cows by walking them three miles had the effect of increasing the fat test. Increased activity on the part of the cow during the day has been considered as a possible reason for the increased fat test and decreased milk yield at the evening milking. Campbell's (*2*) observations, on the other hand, were that such factors as exercise, quantities and kinds of feed, rainfall and lack of drinking water were not important in influencing fat test, but that temperature variations during the twenty-four-hour day may be a contributing factor of some importance. Equalizing the two intervals in the twenty-four-hour day has failed to change these characteristics of morning and evening milk. A careful study of the performance of the cows milked at regular twelve-hour periods showed that the yield of milk is consistently higher at the morning milking and that the actual yield of butterfat is about the same at both morning and evening milkings. That being the case, the fat level or percentage is of necessity higher in the evening milk. The variation in fat level would seem therefore to be attributable largely to the varying quantities of the non-fatty portions of the milk rather than to the actual amount of fat secreted. Such an explanation is plausible only in the light of the theory that butterfat is secreted somewhat independently of the other portions of the milk, and there is some evidence to support such a contention. An alternative to the theory advanced would be that fat is absorbed after the udder becomes full or distended.

Certain recent workers, Swett (*15*) and Gaines (*5*) have found reason to believe that, contrary to older theories, milk is secreted continuously. Turner (*16*) has shown, however, that the rate of secretion decreases steadily with the filling of the udder. There is reason to suspect that the fullness of the udder influences fat secretion and that fat secretion is inhibited when the udder becomes distended. In any case, the difference in length of intervals between normal milkings will not account for the marked test variability of morning and evening milk.

FREQUENCY OF MILKING.

When cows are milked three times a day as R. O. P. and other heavy milkers frequently are, it is desirable to divide the twenty-four-hour day as evenly as possible. Data gathered from cows milked at 6 A.M., 2 P.M., and 10 P.M. show that the yield of milk was highest in the morning and lowest at night. The highest fat test, on the other hand, has been secured from the mid-day milking, and the lowest from the morning. The yield of fat, as shown in the table of data, is less variable. The fat tests, fat yields, and milk yields for two representative cows milked at eight-hour intervals for a period of ten days are shown in Table 8.

TABLE 8.—*Variation in percentage of fat and yield of fat found in milking at eight-hour intervals.*

Cow No.	Milking	Ave. % Fat	Ave. Fat Yield	Ave. Milk Yield
A 11	Morning	3.84%	.472 lbs.	12.35 lbs.
	Noon	4.29	.449	10.44
	Evening	4.28	.441	9.69
H 16	Morning	3.42%	.499 lbs.	16.41 lbs.
	Noon	4.08	.493	12.09
	Evening	3.68	.429	11.77

Morgan and Davis (*13*) have reported a tendency for additional daily milkings to increase the percentage of fat in milk. The percentage increase in fat yield was greater than the percentage increase in milk with increased numbers of milkings in the day. Observations by Woodward (*19*) are that, over long periods, cows milked three times daily produced 20% more milk and 21% more fat than cows milked twice daily. The theory is advanced that the more frequent milkings increased both milk and fat by relieving pressure within the udder and allowing secretion to go on more freely.

WATER CONSUMPTION.

To secure some information for future guidance, attempt has been made to determine the effect of a limited water supply upon the yield and composition of milk, and also to determine the effect of watering the animals at long intervals. Three cows were used in the experiment and a fourth was kept as a check. All the cows were milked twice daily at 4.30 P.M. and 5.30 A.M. The check cow was watered from the automatic system. The average daily production of the cows for ten days prior to the experiment, during which time all cows had continual access to water, was as follows:

	Experimental Cows	*Check Cow*
Average milk yield	24.477 lbs.	26.76 lbs.
Average test	3.52%	3.75%
Average fat yield	0.848 lb.	1.00 lb.

During the following seven-day period, the experimental cows were given all the water they would consume twice daily, a record being kept of the quantity consumed by each cow. The average daily production figures for the period are given below:

	Experimental Cows	*Check Cow*
Average milk yield	24.382 lbs.	28.032 lbs.
Average fat test	3.775%	4.033%
Average fat yield	0.908 lb.	1.13 lbs.

The average water consumption, night and morning, was determined for each experimental cow during this period. They all consumed more water at night than in the morning. During the following five days, each cow used in the experiment was given exactly half of her usual morning consumption each morning and half of her usual evening consumption each evening. The average daily production figures for the period are given as follows:

	Experimental Cows	*Check Cow*
Average milk yield	20.308 lbs.	25.375 lbs.
Average fat test	3.55%	4.00%
Average fat yield	0.730 lbs.	1.015 lbs.

Following this experiment, the cows were returned to the automatic system for a period of four and one-half days. During the next seven days, the cows used for the experiment were watered at thirty-hour intervals, being given as much water as they would consume each time. The following average daily production figures were obtained:

	Experimental Cows	*Check Cow*
Average milk yield	20.628 lbs.	26.271 lbs.
Average fat test	3.639%	3.871%
Average fat yield	0.742 lbs.	1.017 lbs.

Average daily production for the ten-day period following the experiment was as follows:

	Experimental Cows	*Check Cow*
Average milk yield	21.383 lbs.	27.08 lbs.
Average fat test	3.472%	3.975%
Average fat yield	0.728 lbs.	1.076 lbs.

The small number of cows used in this experiment and the short duration of the various trials render conclusions hazardous, but the work has suggested certain trends that may be significant. A careful examination of the figures quoted in the table dealing with twice-daily watering when the cows were allowed to consume all the water they wanted will show that there is a difference in fat yield of 5.59% in favor of the automatic watering system. Similar results have been obtained elsewhere. There was no significant change in the fat test as a result of this treatment. When the cows were given only half the usual amount of water, there was a net decrease in fat production of 7.43% after allowing for the decrease in production of the check cow. This corresponds with the results obtained elsewhere (*12*).

Watering the cows at thirty-hour intervals resulted in a slight increase in the fat test, but the fat yield was not altered to a significant degree. No noticeable physical harm resulted from the treatment given to these cows.

When the cows were watered twice daily, the average consumption for the 24 hours was 132.4 pounds. When watered at thirty-hour intervals, the average consumption per period was 131.4 pounds, equivalent to 105.9 pounds in a twenty-four-hour day. On a percentage basis, this equals a decrease of 20.0% in water consumption per day. This experiment was conducted in the months of November and December 1930.

CONCENTRATE RATIONS.

In a series of feeding trials conducted in the winter of 1930-31, single grain feeds and grain combinations were fed to five cows over a series of experimental periods. The experiment was conducted for 90 days and was divided into nine ten-day periods in which different grain rations were fed. The list of grain rations used follows:

1—Ground barley and oat feed (equal parts by weight).
2—Ground oats.
3—Ground recleaned screenings.
4—Ground barley.
5—Ground oats and oil cake (equal parts by weight).
6—Ground recleaned screenings and oil cake (equal parts by weight).
7—Ground barley and oil cake (equal parts by weight).
8—Wheat bran and oil cake (equal parts by weight).
9—Ground barley and oat feed (equal parts by weight).

The cows in this experiment were milked twice daily and every milking was sampled and tested. The milk yield did not vary much from the mean through the entire period. The only marked deviation from the average fat level through the entire period of the test was the drop in fat test during the third period, when straight recleaned screenings were being fed. This is particularly interesting because of a simultaneous change in the condition of the bowels of all the test cows. All cows became very laxative and two actually scoured at times during the feeding of the straight screenings. The drop in test at this time would strongly suggest one of two things: either that there was something specific in the screenings to cause a lowered fat test, or that the laxative condition of the bowels depressed fat level and fat yield. Just how the condition of the bowels may be related to the level of fat is yet to be established, but unconfirmed observations by the writers would suggest a relationship between a laxative condition and lowered fat test.

It is admitted that the periods of feeding are too short to warrent definite conclusions, but when allowance is made for the normal up-swing in test that accompanies advancing lactation, the results would point to the idea that ordinary grains influence fat tests little if any. Turner (*16*) states that no feeds have yet been found which would permanently increase the fat content of milk.

PROTEIN LEVEL.

The feeding experiments of 1930-31 already referred to failed to show a consistent change of fat level that could be attributed to the percentage of protein in the ration. Briefly, the same average fat test was obtained from a high-protein ration of equal parts of bran and oil cake; a medium protein ration of barley and oil cake; and a low-protein mixture of oats and barley.

In the winter of 1931-32, four pairs of milking cows were fed grain rations possessing varying levels of protein. Pair No. 1 received a low-protein grain ration with a nutritive ratio of 1: 6.3; pair No. 2, a low medium protein grain ration with a N. R. of 1 : 4.9; No. 3, a medium high protein ration with N. R. of 1 : 3.7; and No. 4, a high protein grain ration with a N. R. of 1 : 2.7. Samples were taken from every milking throughout the experiment and, after two months on the above rations, the lots were changed around so that No. 1 went on medium-high protein, No. 2 on high protein, No. 3 on low protein and No. 4 on low-medium protein ration.

Feeding continued for an additional two months with the result in average fat test as shown in Table 9.

TABLE 9.—*Influence of protein level of grain rations on percentage of fat.*

	Ave. % Fat 1st period	Ave. % Fat 2nd period	Difference in % Fat
Group 1—Low protein to medium high protein	3.25	3.52	0.27
Group 2—Low medium protein to high protein	3.83	3.98	0.15
Group 3—Medium high protein to low protein	3.45	3.42	−0.03
Group 4—High protein to low medium protein	3.76	4.02	0.26

Three groups advanced in fat test. An increased test is to be expected during the second period of the experiment due to advancing lactation. Inconsistency between groups 3 and 4 is quite apparent. Group 4, going from a high to a low protein, showed large increase in fat test, while group 3, also going from a high to a low protein, in spite of advancing lactation, showed an actual decrease in average test. The protein levels of the various experimental rations used thus far have apparently failed to influence the fat levels in any significant way.

SILAGE.

For a ten-day period commencing Nov. 19th, 1930, five cows in the University herd received the usual winter allowance of sunflower silage, namely, 20 pounds each daily. During the following ten-day period no silage was fed and there was but a negligible change in the level of fat in the milk. The silage in this period was replaced by choice hay, so that the milk yield was maintained. The third period of ten days was a period of heavy silage feeding. In this period, the two Ayrshire cows received 42 pounds each daily and the three Holstein cows, 45 pounds each daily. The average test for all cows during this period was the same as for the first period. For the final ten-day period, the silage rations were reduced to about one-half. Each cow received 20 pounds of silage daily. Still there was no significant or consistent variation in the average butterfat test; and, as far as this test is concerned, one would be led to believe that the sunflower silage had no well defined effect upon the level of fat. Incidentally, it is worthy of note that the milk yield did not respond to silage feeding as might be expected. The average fat tests for the cows in this series of feeding trials are shown in Table 10.

TABLE 10.—*Influence of silage on percentage of fat.*

Cow's No.	A1 % Fat	A2 % Fat	H1 % Fat	H2 % Fat	H3 % Fat	Ave. for 5 cows	
						% Fat	Lbs. Milk Daily
10 days, 20 lbs. silage daily	3.74	3.87	2.96	3.32	3.98	3.58	20.90
10 days, no silage	3.96	4.14	2.64	3.63	3.91	3.65	21.38
10 days, 42 to 45 lbs. silage daily	3.81	4.01	2.80	3.42	3.87	3.58	20.43
10 days, 20 lbs. silage daily	3.84	4.01	2.48	3.19	3.96	3.50	21.06

BREWERS' GRAINS.

There is an opinion held by some farmers that wet brewers' grains will have a depressing effect upon the fat test when fed to dairy cows. The experience gained in this feeding trial would not bear out such a contention, and, while the experiment is not extensive enough to be authoritative, the actual result was an increase in fat test when the grains were fed. The brewers' grains were given to four cows that were being fed in the barn and which were out for only a few hours daily. The brewers' grains replaced the ordinary grain in the ration and about three and one-half pounds of the wet brewers' grains were regarded the equivalent of one pound of the regular meal fed. The difficulty of obtaining this product as required made it necessary to divide the 46-day experiment into periods of unequal length. These periods, however, ran concurrently, beginning on the evening of March 21, 1931. The average tests for the four cows will be seen in Table 11.

TABLE 11.—*Influence of wet brewers' grains on percentage of fat.*

No. of Cow	A1 % Fat	A2 % Fat	H1 % Fat	H2 % Fat	No. of Tests	Ave. for 4 cows
4 days with no brewers' grains	3.95	3.89	2.56	3.79	31	3.58
4 days with brewers' grains	4.24	3.90	2.51	4.12	32	3.69
9 days with no brewers' grains	4.09	4.12	2.65	4.14	70	3.76
9 days with brewers' grains	4.31	4.31	2.76	4.86	72	4.06
10 days with heavy feeding brewers' grains	4.12	4.09	2.96	4.98	80	4.04
10 days with no brewers' grains	4.09	4.06	2.66	4.98	78	3.95

INFLUENCE OF VARIATIONS ON COMPOSITE SAMPLING

Fat tests from composite samples are frequently the basis upon which the value of milk shipments received at dairy plants is estimated. The factors which are recognized as of importance to ensure the accuracy of such tests are: careful sampling, careful testing and protection of the sample bottles. The sample should be a proportionate quantity of the amount of milk in the shipment. The use of composite samples for these purposes is based upon the assumption that the mixed milk of a herd will be comparatively uniform in test from day to day, and that random samples from the milk of an individual cow will accurately represent the average fat test of her milk. This is not always true. Investigation has frequently shown differences in the average daily test of five cows, chosen at random, as great as 0.5% from one day to another. If the composite sample was taken on occasions of high fat tests, the result would be a considerable over-payment; likewise, if the samples happened to be taken on days of low test, the producer would lose. In herd testing work in which a large number of tests are made at different times, such discrepancies may cancel out; but, when the composite sample consists of three portions, taken at intervals over a fifteen-day period and the payment to the producer is based upon this test, it is obvious that an unde-

sirable element of chance enters into the result. For this reason, it is to be recommended that milk plants take samples daily.

Discussion

A review of the literature on butterfat variations shows that little attention has been focused upon actual fat yield as compared to fat test. The test and its fluctuations are undoubtedly important, but test alone does not give a true picture of the quantity of fat secreted, which, after all, is of the greatest importance. In the experiments reported herein, the fat yield as well as the test was considered when it was practically possible, although it is agreed that additional data about the yield would have increased the value of the work. It is to be hoped that workers in this field will, in the future, give as much thought to the question of yield as to percentage of fat.

With our present knowledge, we cannot account for the very apparent day-to-day variations in fat level and yield. The fact that the fat test of milk drawn from one quarter of the udder may vary widely from that of the other quarters and that the fat level relationship between the quarters may not be maintained from one milking to the next, indicates that environment and treatment are not alone responsible for the erratic daily variations. Observation leads to the belief that change of milkers and irregularity of milking and feeding tend to increase variability. Completeness of milking may obviously alter the fat content of milk to an appreciable extent. Such factors as sickness of the cow and oestrum, which are difficult to study experimentally, may have a marked effect upon the fat test.

It is frequently assumed that variations in fat content of milk are usually confined to the milk of an individual cow and that these variations tend to offset each other, resulting in a fairly uniform test in the milk of a herd. The extent to which milk composition is influenced by the many environmental factors that have been considered is not known, but it is reasonable to suppose that these might occasionally influence the milk of all cows in the same direction. It has been found that the average daily test of several cows may change to an important extent. This factor of variability in herd milk should be considered in any estimate of the reliability of composite samples, especially when the tests being made are the bsais upon which the producer is paid.

It has been reported that the condition of the cow at freshening time may influence the percentage of fat in the milk for a short period immediately following parturition (*4*). Breeders have taken advantage of this fact to increase the fat test of their cows' milk during the short time official tests which were popular a few years ago. It has been observed that the milk from a highly conditioned cow may be as rich or richer in fat for a period after freshening than it will be at the close of the lactation when the fat test normally ascends.

The fact that the fat content of milk varies much more than the solids not fat is very interesting and suggests that the production of these milk constituents in the udder may be more or less unrelated processes. A cow that normally produces milk with a low fat content will usually produce a milk having a low percentage of solids not fat, but the latter will be much more constant than the former.

Certain factors influence the fat test over long intervals and the effects of these have been carefully studied. It is not entirely satisfactory, however, to say that a certain trend is due to "season" of the year. When more information is available, it may be possible to separate this factor into certain components such as temperature, milk flow, etc. Similarly, it may be possible to separate the factor, "stage of lactation" into a number of factors which influence the physiology of the animal such as pregnancy, etc.

There has been much discussion on the question of the influence of feeds upon the fat test. Cod-liver oil in large doses has been shown to exert a definite depressing effect (*6*) and this seems to be true also for linseed oil (*14*). Reports regarding the influence of other fat-rich feeds are contradictory (*14*) (*9*). Changing cows from ordinary barn feeding to green pasture is popularly supposed to increase the milk flow and lower the fat test. There is some evidence that this conception may be incorrect (*10*).

Conclusions

1. Day-to-day variations are so great and are so influenced by the individuality of the cows that early experiments conducted with single cows cannot claim much significance.

2. The fat test tends to decrease during the first four months of the lactation period and to increase thereafter, especially during the last month.

3. The lowest average herd test was obtained in July and the highest in February.

4. Age of animal has but little influence upon fat test, with a tendency for lower levels during later life.

5. The first milk withdrawn from the udder is the lowest in butterfat and the strippings are the richest. The fat test may range from 1.0 to 10.0% in the successive portions of one milking.

6. The percentage of solids not fat remains relatively constant in the milk of a given cow.

7. The common cereal grains and grain rations used did not alter butterfat test significantly.

8. Varying the proportion of protein in the cow's ration did not produce a significant and consistant change in the butterfat tests.

9. Wet brewers' grains do not depress fat yield, and tend only to lower the test percentage when the yield of milk is increased.

10. Heavy or light feeding of sunflower silage did not change the butterfat test in a significant manner.

11. Frequent sampling of milk is essential to accuracy in semi-official cow testing. Composite samples of milk as used by dairy plants should consist of daily aliquots.

12. Reduced allowances of drinking water and long intervals without water had the effect of slightly reducing milk and fat yield, but did not significantly alter the test.

13. Increased milk flow tends to lower the fat test and vice versa.

14. The secretion of fat in the udder and the secretion of the non-fatty constituents may be independent processes.

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A NOTE ON MYCOTIC PNEUMONIA OF CHICKENS

A. Savage[1] and J. M. Isa[2]
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[Received for publication August 20, 1932]

Pneumonia in brooder-raised chicks, as a result of their becoming infected with various species of mould, is mentioned in most text books on veterinary pathology as if it were a common occurrence. The writers' observations have been quite the contrary. For this reason and in the hope that it may serve as a warning to practical poultrymen, the following note is published.

Last June, a farmer near Winnipeg bought 400 day-old chicks and placed them in a clean, suitably constructed brooder house. As litter he used some of the dry corn ensilage which happened to remain in the bottom of his silo. In a few days the chicks began to die at first by twos and threes, then by tens, finally by scores until, when the mortality had reached 90%, he sought help.

The sick chicks displayed no special symptoms except that they gasped. This began unobtrusively and became progressively worse until, in three or four days, chirping ceased and the birds died.

Blood tests for B.W.D. were negative. On post-mortem examination only the lungs showed gross change. They displayed diffuse, slightly yellow infiltrations, affecting not less than one third of each. There were no circumscribed yellow spots. The affected portions sank in water.

Microscopically it was possible to demonstrate mycelium in freshly prepared smears. From several affected lungs the Plant Pathology Department here isolated and identified *Aspergillus fumigatus*, in less than 36 hours.

Cut sections, prepared by the paraffin method, showed the usual changes incidental to acute broncho-pneumonia. It was exceedingly difficult however to demonstrate the infecting agent. Dozens of staining methods were tried but not more than a few fragments of mycelium could be recognized in any one section. The use of carbolfuchsine (2 minutes) with subsequent incomplete decolorisation by alcohol saturated with picric acid, produced a fairly satisfactory differentiation of host and parasite. As the accompanying photographs show, the mould was evidently growing in a highly unfavorable medium which modified it profoundly.

Cultures of the dry ensilage on acidified Czapek's agar (pH about 4.) showed a rich mould flora. *A. fumigatus* was abundantly present. Because of the pathogenicity of this species for mammals, it is possible that there may be subsequent chapters to this episode.

Our thanks are freely expressed to Dr. G. R. Bisby for the isolation and identification of the mould involved.

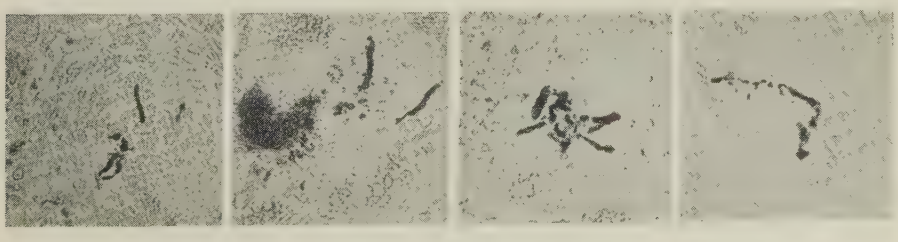

Figure 1. Fragments of mycelium in lung, ×300.

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THE USE OF THE GEOMETRIC MEAN IN DETERMINING GROWTH RATES[1]

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[Received for publication August 15, 1932]

In the July 1932 issue of Scientific Agriculture, (Vol. 12, No. 11), Lerner and Asmundson, in their article on "Inheritance of Rate of Growth in Domestic Fowl", outlined the usually accepted formulae for rates of growth and have considered Minot's modified formula as the most suitable formula. It is true that this formula, based on the arithmetic mean, is a great improvement on Minot's simple formula but it will always give a slightly low result as compared to the logarithmic formula. This is, as pointed out by Brody, due to the fact that as much emphasis is placed on the final weight, upon which no growth has occurred, as upon the first weight. The rate should, of course, be based on some intermediate value or values, and this fact suggested to me the use of the geometric mean.

Growths, within certain periods, are at constant rates as can be easily shown when plotted on semi-log. paper. Assuming then the weights for this period of constant rate to be at equal intervals W_1, W_2, W_3, then it follows that $\frac{W_2}{W_1} = \frac{W_3}{W_2}$ hence $W_2 = \sqrt{W_1 W_3}$. This is, of course, the Geometric Mean of the first and final weight and is a value which most probably occurs at the mid-point of the given period and is a logical value to use as a basis for determining rates.

The suggested formula is $R = \frac{W_2 - W_1}{(t_2 - t_1)\sqrt{W_2 W_1}} \times 100$

where W_1 and W_2 are the first and final weights at times t_1 and t_2.

These values should be chosen as points lying on the line of best fit on a semi-log. graph to get the general trend of growth. The value obtained by this formula is invariably much nearer the logarithmic value than Minot's Modified. In fact in some results worked out on chicken growths I find that this formula gave rates approximately 1 to 2% high while Minot's formula gave rates from 3 to 4% low as compared to the logarithmic value. It has an added advantage in that it is simpler to work out the result on a slide rule as the only calculation which cannot be done on the rule is $W_2 - W_1$, while in Minot's Modified formula the calculation of $\frac{W_1 + W_2}{2}$ must also be done on paper.

The following results for the rate of growth of the white rat, by the four methods from data given by Brody, illustrate the relative merits of these different formulae. The weights at 2 and 9 days are respectively 5.9 and 11.7 grms.

[1]This method has been used by the author to work out growth rates in some experimental work done by Dr. Earl J. King of the Department of Medical Research, Banting Institute, University of Toronto. This work has been published by Dr. King in the Canadian Medical Association Journal, *25*; 535-543. 1931.

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Minot's $$R = \frac{11.7 - 5.9}{5.9 \times 7} \times 100 = 14\%$$

Minot's modified $$R = \frac{11.7 - 5.9}{\left(\frac{11.7 + 5.9}{2}\right) 7} \times 100 = 9.4\%$$

Geometric mean $$R = \frac{11.7 - 5.9}{7\sqrt{11.7 \times 5.9}} \times 100 = 9.95\%$$

Logarithmic $$R = \frac{\log 11.7 - \log 5.9}{7} \times 2.303 \times 100 = 9.80\%$$

This shows that the Geometric Mean formula gives a value much closer to the Logarithmic or true rate than the others, and those accustomed to using a slide rule will see that it is easier to work out than Minot's modified.

CURRENT PUBLICATIONS

SOIL MANAGEMENT. R. Summerby, Professor of Agronomy, Macdonald College, P.Q. Farm Bulletin No. 4.

As stated in the preface, "The purpose of this bulletin is to present information on soil management that will be of value to the practical grower. It seeks first of all to show the relation between soils and crops, then to make clear the basis upon which improvement may be made, and finally, to indicate practical measures of soil management by which crop yields may be maintained or increased with profit."

The author has succeeded in preparing a good practical bulletin which should be of assistance to farmers in general and should be especially suitable for junior farmer courses. The bulletin is printed clearly and contains sufficient illustrations to hold the interest and explain some of the essential points in the text. It is to be commended as a type of publication which is capable of wide use throughout the territory for which it is written.

CURRENT PUBLICATIONS

THE GREAT DEPRESSION AND BEYOND. Lloyd M. Graves, economic advisor to the Brockmire Economic Service. Published by the Brockmire Economic Service. Price $2.50.

The author of this interesting study disclaims any intent to present a definite history of the depression, adequate factual basis for which does not yet exist. It purports to be an essay on the main tendencies in twentieth century civilization. Such a purpose gives ample score for presenting many of the causes which underlie current conditions, and which so far have received scant attention.

The author claims that the fundamental difficulty confronting the world is the impossibility of Europe either to feed itself or find markets in which to exchange manufactured goods for food products. This condition arises from an excess of population in some sections of Europe, a condition developing prior to the Great War, and one which would no doubt have caused the depression of 1913-14 to assume some of the aspects of that of the present had the war not intervened.

The war stimulated expansion, expanded international credit, allowed speculation and led to the credit collapse. A sound currency is essential for the capitalistic system to function. The difficulty, if not impossibility, of maintaining a sound currency decreases business. The choice is now available, and must soon be made, between important modifications and adaptability of the present order to changed conditions, or the substitution of a new system. The modern revolutionary will not be interested in the "right" of property but rather in the provision of a job or, failing that, public relief.

If the experience of government in business or that of the Federal Reserve Board in finance in controlling speculation may be taken as evidence, planned economy is not attractive. The United States matures, is over industrialized, and future expansion, restricted to changes in technique dependent on research and invention, must be less rapid.

Probable losses by American investors will prevent resumption of international credit for some time, limit exports and force readjustment of productive programmes and living conditions. The world is neither an economic nor a political unit.

The detail upon which this argument is founded is interesting and valuable. Something of a world picture is presented by chrts and figures. Among the many points of special interest most striking perhaps are the discussions of the danger to the whole credit structure from the present position of the two industries of agriculture and transportation; the methods by which the small investor is separated from his capital; the futility of endeavoring to persuade the public to listen to or the press to print anything but optimistic news during the early phases of the depression; and the general futility of dependence on democracy. While certain policies recommended would not be applicable to Canada, yet this volume must be intensely interesting to Canadian readers. —J. E. Lattimer

RESUME DES ARTICLES PUBLIES EN ANGLAIS DANS CE NUMERO

L'AVENIR DE L'AGRICULTURE CANADIENNE DANS LE COMMERCE A L'INTERIEUR DE L'EMPIRE. Par J. E. Lattimer, Macdonald College, McGill University, P.Q.

Le Dr. Lattimer, qui a passé quelques mois en Europe l'été dernier, donne ses impressions sur la tendance du commerce mondial en matières alimentaires. Pour comprendre les changements qui ont pris place il donne une idée du commerce international en général, mentionnant en passant quelques-unes des causes de la dépression actuelle. Les conclusions générales du Dr. Lattimer sont les suivantes:—

Les importations de la Grande Bretagne en matières alimentaires ont considérablement augmenté depuis la guerre. Ces importations proviennent de beaucoup de pays en dehors de l'Empire. Quelques-uns de ces pays étrangers s'efforcent de disposer de leur surplus de matières alimentaires en Grande Bretagne tout en prohibant rigoureusement l'entrée des marchandises britanniques. L'augmentation du commerce à l'intérieur de l'Empire est devenue une nécessité. Les importations de grain sont restées presque stables tandis que les importations de viande, de fruits, de produits laitiers et de volailles ont augmenté matériellement. Les produits du pâturage sont fournis assez généralement par des parties de l'Empire situées dans l'hémisphère austral. Le bacon, les oeufs et les volailles sont largement importés de l'étranger. Les importations britanniques de grain n'ont pas augmenté tandis que les marchés européens en dehors de la Grande Bretagne sont devenus presque inaccessibles. La transformation du grain en produits plus demandés est devenue essentielle. C'est là qu'est l'avenir de l'agriculture canadienne dans le commerce à l'intérieur de l'Empire.

Les techniciens de la Province de Québec s'intéresseront sûrement aux remarques du Dr. Lattimer sur la situation du porc à bacon dans la Province à la page 299.

ETUDE SUR LES METHODES D'ISOLEMENT DE CHAMPIGNONS DE LA RACINE ET DU GRAIN DE BLE. Par H. W. Mead, Laboratoire Fédéral de Pathologie Végétale, Saskatoon.

L'Objet de cette étude a été de déterminer des méthodes efficaces pour se débarrasser de la contamination superficielle des racines et des grains de blé sans affecter les champignons internes que l'on veut isoler pour les étudier. Le lavage a donné de bons résultats. Des solutions savonneuses et l'alcool ont été utilisés dans l'appareil à laver en conjonction avec de l'eau stérilisée dans le but de mouiller le matériel avant le lavage. L'eau oxygénée a donné d'assez bons résultats mais la concentration de la solution est difficile à maintenir. L'hypochlorite de chaux fraîchement fait est assez satisfaisant pour l'isolement mais la durée du traitement (20 minutes) n'est pas suffisante pour assurer une stérilisation complète des graines. Une solution aqueuse ou alcoolique de chlorure mercurique n'a pas donné de résultats entièrement satisfaisants en ce qui concerne le travail avec les racines mais a donné une très bonne stérilisation des grains sans influencer sérieusement leur faculté germinative. Une solution de nitrate d'argent au centième de la normale s'est montrée sans valeur pour le travail d'isolement mais a donné d'excellents résultats pour la préparation de jeunes plantes stérilisées.

ETUDE SUR LA ROUILLE DE LA COURONNE, PUCCINIA CORONATA CORDA. Par W. P. Fraser and G. A. Ledingham, Université de Saskatchewan, Saskatoon.

Cette étude présentée au Congrès de la Société Canadienne de Pathologie Végétale rend compte de recherches sur le développement de la rouille de la couronne avec l'aide de graminées sauvages de l'Ouest du Canada. L'étude mentionne les différentes lignées de rouille et les hôtes alternes qui interviennent pour leur propagation.

Variations dans la Teneur du Lait de Vache en Matieres Grasses. Par J. W. G. MacEwan et V. E. Graham, Université de la Saskatchewan, Saskatoon.

Les variations journalières sont si grandes et le facteur individuel joue un rôle si important que les expériences conduites avec une seule vache n'ont pas grande signification. La teneur en matières grasses tend à décroître pendant les 4 premiers mois de la période de lactation, puis à remonter, notamment pendant le dernier mois. La moyenne la plus basse pour un troupeau a été obtenue en juillet et la moyenne la plus haute en février. L'âge de l'animal a peu d'influence sur la contenance en matières grasses, la tendance étant vers une baisse dans la période la plus âgée. Le premier lait tiré du pis est le moins riche et le dernier lait le plus riche. La teneur en matières grasses paut varier de 1.0 à 10.0% au cours d'une même traite. Le pourcentage de solides autres que les corps gras, reste relativement constant dans le lait d'une vache donnée. Les rations de céréales utilisées n'ont presque pas changé la teneur en matières grasses. Les proportions de matières azotées dans la ration ne semblent pas avoir d'influence sur le pourcentage de matières grasses. Les déchets de brasserie ne font pas baisser la teneur en matières grasses sauf quand la production de lait est augmentée. Le tournesol ensilé donné en fourrage n'a pas d'influence. De fréquentes prises d'échantillon du lait sont essentielles pour l'exactitude des résultats. Une réduction dans la quantité d'eau bue et de longues périodes sans eau ont eu pour effet de réduire largement la production de lait et de matières grasses sans altérer l'analyse d'une façon importante. Une augmentation de la production laitière tend à faire baisser la quantité de matières grasses et vice versa. Les secrétions dans le pis des matières grasses et des matières non grasses peuvent être de processus indépendents.

Notes sur la Pneumonie Mycotique des Poulets. Par A. Savage et J. M. Isa, Université du Manitoba, Winnipeg.

Les auteurs décrivent le développement d'une épidémie de pneumonie dans un groupe de 400 poussins âgés d'un jour. Le propriétaire avait utilisé comme litière de l'ensilage de maïs séché qui se trouvait rester au pied du silo. L'examen clinique a montré que le mycélium de *Aspergillus fumigatus* se trouvait abondamment dans les poumons. Des cultures de l'ensilage sec ont produit le même mycélium. La mortalité ayant dépassé 90% il est évident que l'ensilage de maïs ne convient pas comme litière pour les poussins.

L'Emploi de la Moyenne geometrique pour determiner les taux de Croissance. R. C. Moffat, Collège d'Agriculture de l'Ontario, Guelph, Ont.

L'auteur discute un article de Lerner et Asmundson dans le numéro de juillet de "La Revue Agronomique", article dans lequel la formule de Minot modifiée était présentée comme la plus pratique pour le calcul des taux de croissance. L'auteur suggère l'emploi de la moyenne géométrique dans ce but et présente une formule utilisée par lui-même au cours de travaux antérieurs. Une comparaison avec la formule de Minot montre que la formule basée sur la moyenne géométrique donne des résultats plus proches de la valeur vraie du taux donnée par la formule logarithmique.

ERRATUM

In the abstract entitled "Base Exchange Studies of Some Red River Soil Associates" on page 133 of the October 1932 issue of *Scientific Agriculture* (Volume XIII, No. 2), read as follows for the last paragraph on the page, "In the Degraded soil associate which had grey round topped columnar structural aggregates the divalent cations had decreased to approximately 80% of the total absorbed bases and hydrogen, but the calcium had decreased to less than 40% while the magnesium had increased to over 40% and the hydrogen to 16%."

CONCERNING THE C.S.T.A.

WORK OF THE C.S.T.A. COMMITTEE ON EDUCATION AND EXTENSION.

The following memorandum has recently been forwarded by the Chairman to members of the C.S.T.A. Committee on Education and Extension for transmission to the different locals.

"During the 1931-32 Society year the local branches of the C.S.T.A. were each asked to appoint committees on research. These committees drew up reports which they submitted to the locals for discussion and which were later forwarded to the C.S.T.A. Committee on Research. Out of the work of this committee has developed the project of surveying the different fields of agricultural research activities, of listing the projects under way, and of then determining the trends with a view to pointing out the strength and the weakness in each field. This task has been definitely undertaken by the C.S.T.A. and its affiliated groups.

"During the present Society year the Committee on Education and Extension is making a careful survey of extension activities and methods. This subject was discussed at the National Conference on Agricultural Services held in Toronto last August and a "Committee on Extension, Publicity, and Publications" brought in a general report which was accepted. A copy of this report has been forwarded to the secretary of each local.

It is suggested that particular attention be paid to the following points stressed in the Report from the National Conference:

I. Co-ordination of services. This includes division of services where feasible and close co-operation through programme planning in all cases. It includes not only the relation of extension services of one government to extension services of another, but the relation of research services to extension services. Are extension men receiving research results in the form in which they can most readily use them and keep abreast with the advances in agricultural research? This latter question raises the point of the over-crowding of the extension man's programme which often leaves him too little time to assimilate scientific material.

II. Variation in methods due to regional conditions. This raises the questions of size of constituency, types of demonstrations, illustration stations and demonstration farms, short courses, club work, agricultural societies, competitions, community programmes, relation to co-operative marketing, and many other points of more limited application. Some attempt should be made to agree on fundamental features of work over well marked regions.

III. The effectiveness of various forms of publicity and publications. Exclude from this section the field demonstrations and demonstration farms in Section II. and consider exhibits at fairs and conventions, and the various forms of publications made available to the farmer. The effectiveness of bulletins, pamphlets, circulars, posters, farm journals, daily or weekly press items, etc., should be evaluated if possible.

In appointing committees for this project, administration, extension and research men should be included. Particular effort should be made to get the opinions of the field men themselves on many of these problems which they should be ready to discuss. Committees, having framed a report, should present it for discussion to the local if possible, and forward it to their representative on the C.S.T.A. Committee on Education and Extension by May 1st, 1933."

The members of the Committee listed below have charge of securing the information for this survey from the various Locals following their respective names:

Dr. W. J. Black (Chairman) Canadian National Railways, Montreal, P.Q. Prince Edward Island, Nova Scotia, New Brunswick, Montreal City, Macdonald College.

Dr. L. P. Roy, Department of Agriculture, Quebec City, P.Q. Ste. Anne de la Pocatiere, Quebec City, Montreal District, Quebec Eastern Townships, Northern Quebec and Ontario.

Mr. R. S. Duncan, Department of Agriculture, Toronto, Ont. Eastern Ontario, Central Ontario, Ontario Agricultural College, Niagara Peninsula, North-western Ontario.

Dean A. M. Shaw, University of Saskatchewan, Saskatoon. Manitoba, North Saskatchewan, South Saskatchewan, North Alberta, South Alberta.

Dean W. C. Clement, University of British Columbia, Vancouver. British Columbia.

Executives of the various Locals are asked to give this matter their prompt attention as soon as they hear from the Committee on Education and Extension. This survey is in line with previous work done by committees of the C.S.T.A. It is particularly important at the present time that we have reliable information on which to base recommendations of the C.S.T.A. to the National Advisory Committee on Agricultural Services. Members who desire to comment individually on these questions are requested to communicate direct with the officers of their Locals or with the General Secretary or any of the elected officers of the Dominion Society.

INTRA-EMPIRE TRADE

The Opportunity for Agriculture

Members of the C.S.T.A. are all urged to read the article appearing in this issue under the above title by Dr. J. E. Lattimer, Head of the Department of Agricultural Economics at Macdonald College, P.Q. Dr. Lattimer spent some time in Europe last summer studying world trade in food products. The article which he has written as a result of this trip is, to our mind, the best commentary which has yet appeared on the Imperial Conference which took place in Ottawa last summer.

Technical agriculturists owe it to themselves to have some understanding of the trends in agriculture and of international trade in general. Even though one may be recognized as a well informed specialist in a certain field of agriculture, there are times when it is well to be able to discuss intelligently the whole picture. The present moment is one of the times when a general understanding on the part of everyone is needed. Dr. Lattimer's article should be read and re-read until it is thoroughly understood and can be quoted at a moment's notice in considerable detail.

—H.L.T.